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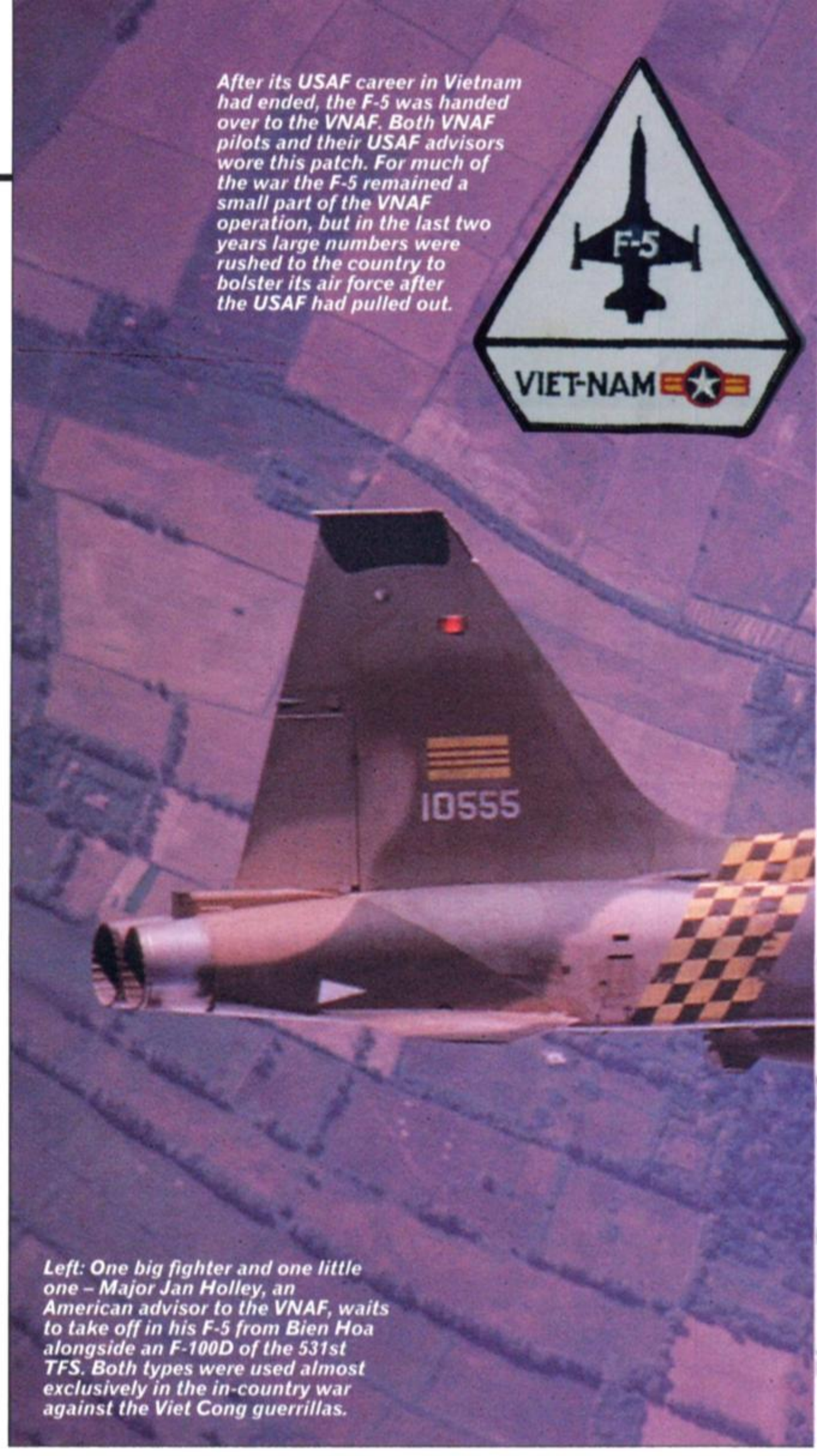
Skoshi Tiger

Cheap to procure and easy to operate, the F-5 could have been an ideal aircraft for USAF service in Vietnam. However, it served with only one unit, initially only as an evaluation squadron. The aircraft were later turned over to the South Vietnamese air force.

After its USAF career in Vietnam had ended, the F-5 was handed over to the VNAF. Both VNAF pilots and their USAF advisors wore this patch. For much of the war the F-5 remained a small part of the VNAF operation, but in the last two years large numbers were rushed to the country to bolster its air force after the USAF had pulled out.



Left: One big fighter and one little one – Major Jan Holley, an American advisor to the VNAF, waits to take off in his F-5 from Bien Hoa alongside an F-100D of the 531st TFS. Both types were used almost exclusively in the in-country war against the Viet Cong guerrillas.

Northrop Aircraft Corporation had designed and produced one of the most versatile and manoeuvrable twin-engined jet fighters in the world. By mid-1965, the F-5 had aroused the interest of many air forces, the majority of them from smaller, secondary countries that wanted a competitive fighter at a fraction of the cost of the state-of-the-art, very expensive F-4 Phantom. By 1966, with the commitment from Ethiopia, Morocco and Thailand, the F-5 international community had grown to 17 countries. The F-5A and B had proved to be one of the most marketable fighter aircraft ever built, especially in the United States. Its potential had not yet peaked. With all of its success, there was still some doubt from many countries who wondered why the USAF did not use the aircraft if it was as good as claimed. At that time – the mid-1960s – there was still a wide variety of aircraft in the US Air Force inventory, and the F-5 was not one of them. To forestall any further questions, Robert McNamara, the Secretary of Defense, authorised the testing of the F-5 in a hostile environment: Vietnam. It would be known as 'Skoshi Tiger', which translated from the Japanese means 'Little Tiger'.

Low-cost fighter

Northrop was producing the F-5 for approximately $750,000, which was less than half the cost of the bigger, more sophisticated fighters. Some of the more perceptive military leaders knew that future conflicts would be fought on a very limited basis and that there was definitely a need for a smaller, less complicated fighter that provided the necessary flexibility and performance. The F-5 was capable of speeds over 900 mph (1450 km/h) in level flight and could easily hit 1,100 mph (1770 km/h) in a dive. It had very good performance at altitudes of 35,000 to 40,000 ft (10670 to 12190 m). The Freedom Fighter had two lightweight engines and the entire airframe had a gross weight of just over 20,000 lb (9070 kg). In 1965, it was the only jet fighter that could effectively operate from sod airfields, and was extremely effective in delivering 6,200 lb (2810 kg) of ordnance.

Colonel Frank Emory would become the commander of the new provisional squadron. He reflected on some of the events that led to the F-5 getting the green light for combat: "Early in the spring of 1965, I was told informally by the DCS Operations TAC that a potential requirement was developing in the Pentagon and State Department to involve the Northrop F-5 fighter in the Vietnam War. Apparently, this ploy was to be used to persuade several of the smaller allied countries to equip themselves with a less expensive and less demanding fighter, such as the F-4 or the F-105. It would quiet the factions that wanted to know why the USAF wasn't using the F-5 if it was so good. The other reason was that there were probably still a number of influential people within the Air Force and the industrial community pushing for a state-of-the-art, lightweight, easily maintained fighter, such as the F-5."

Before any aircraft could be cleared to fly in combat, its capabilities and ordnance delivery ability had to be tested. According to Major

The Northrop F-5 in Vietnam

With four 'slick' Mk 82s, a 522nd Fighter Squadron F-5A rolls into its bomb run. USAF experience with the F-5 had shown the type to be fairly well suited to the short-range missions which prevailed in South Vietnam. Early VNAF operations reflected this to an extent, although the type was criticised for the poor precision of its bombing. This was a factor in the decision not to equip further squadrons (at least prior to the major expansion of the VNAF in the 1970s).

Dick Williams, the Skoshi Tiger project officially began at Eglin AFB, Florida. "It was known as Project Sparrow Hawk and its purpose was to test and prove that the F-5 was a capable fighter for dropping bombs, strafing and close air support. The project began on 15 April and ended on 15 July 1965. The Northrop fighter had to stand against the F-100, F-4, A-4 and the A-1. Not only did it hold its own but, in my opinion, it came out with top honours."

When Sparrow Hawk was completed, the next item on the agenda was to organise a squadron that would train in the F-5 and eventually take it into combat. Williams continues, "This evolved into Skoshi Tiger, and the 32 pilots who were selected all came from the group of pilots that had flown the tests at Eglin. It took long hours and a lot of dedication from the ground crews, but Skoshi was put together in less than 88 days. The maintenance people were fantastic and we had drawn them from 73

Returning from a mission in April 1967, this F-5C was assigned to the 10th Fighter Commando Squadron. The unit was created by raising the evaluation squadron to full operational status, there being no serious plans to introduce any further F-5s to the USAF's inventory.

different Air Force bases."

Special Order No. G-154 stated that effective 22 July 1965, Tactical Fighter Squadron (Provisional) 4503 was designated and organised at Williams AFB, Arizona. It would be attached to HQ USAF/TAWC for operational control. The 4503rd, an all-volunteer unit, would begin training at Williams with 38 officers, 216 airmen and 11 civilians. They were affiliated with the training wing there, taking over the foreign student training facilities, and on 1 August the training schedule began.

Northrop modifications

The new squadron was to be outfitted with 12 F-5As that would come from the Military Assistance Program. Before training could start, the aircraft had to undergo a series of modifications which included the installation of aerial-refuelling probes, armour plating, jettisonable pylons, additional avionics, camouflage paint scheme, formation lights for night missions and additional TAC ordnance certifications. According to Colonel Emory, "Northrop had to design, install and test the aerial refuelling system, which was critical in our flying the aircraft across the Pacific Ocean. They did all of this in three weeks! It was an incredible job on their part!." Major Dick Williams, maintenance officer, adds, "With the new aerial refuelling configuration of the F-5, it became the F-5C. We also installed dual platform gyros in each of the 12 aircraft, as the instrument conditions for instrument flying were not to the American standards. We put hardpoints on the wing. This was where our bomb shackles would carry the heavy bomb loads. There were two on each wing and one centreline hardpoint. This enabled us to carry approximately 6,000 lb of bombs and external ordnance. We could also put a MER rack on the centreline. It only carried an additional 1,000 lb of bombs (250-pounders) and it limited our range significantly! In the other configuration, we could carry four 750-lb bombs along with a centreline tank. We also carried approximately 500 rounds of ammo for our M39 cannon. They fired at the rate of 1,500 rounds per minute."

Above: One of the original 4503rd TFS(P) Skoshi Tiger aircraft is seen immediately before its deployment to Bien Hoa. The refuelling probe was a fixture on all of the early aircraft, although was little used in combat.

Right: Captain Jim Martin taxis his F-5C during the early training at Williams AFB. Before the deployment to Southeast Asia, the 12 Skoshi Tiger aircraft would all receive tactical camouflage. The base in the Phoenix suburbs was also home to the 4441st CCTS, established to provide training for the many overseas customers for the F-5.

Intense training schedule

The Skoshi Tiger training period was anything but a vacation. It was seven days a week, day and night. They set up a munitions dump to handle all the types of ordnance that would be used in Vietnam, and had unlimited use of the tactical range at Luke AFB with live targets. Everyone was checked out in the T-38 and immediately went into the F-5, dropping live bombs and flying hours of close-formation, low-level flights across the unpopulated desert regions of Arizona. This aspect of training was supplemented with the use of live ammunition around the perimeters of the base to gain the expertise in stopping infiltration and mass attacks, just as they would face at Bien Hoa. It was a crash training course that involved everyone in the squadron.

When the initial orders were cut, Northrop stated that it would be eight months before they would have the aircraft ready for Vietnam. This estimate dropped to six months and then down to five. It continued to decrease and, in the end, after 88 days both the 4503rd and Northrop were ready to move to the next phase of the programme: combat. During the brief period at Williams, the squadron flew 1,064 sorties totalling 1,364 flying hours. On 22 October,

Fresh from the paint shop, a 4503rd TFS(P) F-5C taxis at Williams AFB with standard unpainted aircraft in the background. The Skoshi Tiger programme was officially launched on 26 July 1965, the 4503rd being activated on 29 July. Training sorties began on 2 August.

While the 4503rd TFS(P) pilots trained on standard F-5As during August and September 1965, Northrop was busy preparing the operational F-5Cs. All 12 had been received by 11 October.

The 88-day training period at Williams was intense. The Skoshis used the Luke ranges to practise weapon drops, and regularly trained in low-level operations. The Skoshi pilots were all highly experienced and the work-up was completed quickly.

the squadron deployed from Williams AFB en route to Southeast Asia. A team of evaluators accompanied the squadron to monitor the accuracy of the weapons and the ease of maintaining them in forward areas, and to determine how well they could manoeuvre and survive in a hostile environment.

The squadron loaded most of its personnel and equipment on C-130s and C-124s and headed to Bien Hoa Air Base, South Vietnam. The following morning, the pilots climbed in their F-5s and began one of the longest flights ever flown by the little Northrop fighter. Colonel Emory remembers, "We flew from Arizona to Hickam AFB, Hawaii, then to Andersen AFB on Guam. From there, to Vietnam. We did this in two and a half days with aerial refuelling between stops. On the afternoon of our arrival, we flew combat missions, which was almost unheard of in that day and time. In just a span of 60 hours, we had come from our training base halfway around the world and flown combat! All of this went off without a hitch."

Right: The 4503rd Tactical Fighter Squadron (Provisional) lines up for a photo-session at Williams shortly before its deployment to Southeast Asia. Standing in front is the CO, Colonel Frank Emory.

Below: Four F-5Cs sit on the Williams ramp in early October 1965. They are carrying SUU-20 training dispensers, each of which could carry four 2.75-in rockets and six practice bombs.

Squadron records show that the first strike carried out by the F-5 was against a concentration of Viet Cong, believed to be battalion strength. The flight of 'Tigers' was directed by a FAC, and after the fighters had dropped their ordnance and left the area the FAC radioed that it looked like 90 per cent of the target area had been effectively hit. It had been a memorable beginning. From that mission until the Skoshi Tiger project was completed, the pace never slowed.

First into combat

Captain Robert Terbet had the distinction of having the first combat abort in the F-5. He states, "I would have been on the first series of sorties right after we arrived at Bien Hoa. It was not to be, because one of the 'burners would not light. After several tries, I parked it. When the ground crews checked it out, we found that a pressure line to the afterburner had failed and it was corrected quickly. I will say that the fighter was very responsive and performed well. It was extremely stable, which made it an excellent delivery platform. I remember that the forward air controllers always had positive com-

Above: Three Skoshi F-5Cs refuel from a SAC KC-135A in preparation for the deployment to Vietnam. The tanker required the short hose/drogue addition to the boom to refuel the Freedom Fighters.

Right: Personnel of the 4503rd TFS(P) prepare to board the 1611th Air Transport Wing C-135B which will take them from Williams to Vietnam.

Major Alfred H. Hopkins is seen arriving at Bien Hoa after the Pacific crossing (with overnight stops at Hickam and Andersen), greeted by Brigadier General George B. Simler. Hopkins's aircraft (64-13314) was the first F-5 in Vietnam.

ments on the accuracy of our ordnance deliveries."

The F-5s typically carried the same load as the F-100s, but did not have the 'legs' of the Super Sabre. The tankers made up for this deficiency. For most of the missions that the Skoshi Tigers flew into Laos and North Vietnam, the standard load was four 750-lb GP bombs. Napalm/CBU were the weapons of choice on missions that were flown down south.

The Skoshi Tiger evaluation was broken into four segments that were meant to test the aircraft in every possible situation. The first part would test the F-5 operating from its main base at Bien Hoa. These missions would be in-country, requiring some aerial refuelling and delivering almost every ordnance type that had been brought into the theatre. Phase 2 would move the squadron north to Da Nang AB. For these missions, they would fly under simulated 'forward-operating' base conditions. It was this phase that would test them under pressure in a much more hostile environment. Phase 3 would return them to Bien Hoa for a sustained maximum effort operation. The final segment was brought on by some bad luck connected to Phase 2. When the 'Tigers' moved to Da Nang initially, the United States had declared a moratorium on bombing in North Vietnam, so the test during that period (January 1966) was not conclusive and had to be repeated.

Short-range missions

For the first 60 days in combat, the F-5s were used mostly against in-country targets in a 40-50 mile (65-80 km) radius of Bien Hoa. The evaluation team monitored every mission flown by the 4503rd. It was common knowledge in the squadron that their performances were being compared directly with that of the F-100,

Seen in November 1965, the Bien Hoa ramp was a beehive of activity. The Skoshis were attached to the 3rd TFW, and bedded down next to the F-100Ds of the 307th TFS (replaced in November by the 308th). In the background can be seen C-47s, A-1s and O-1s.

F-4 and F-104, most of which were flying a wide variety of missions out of different bases all over South Vietnam. There was absolutely no advantage being given to the F-5 in test results. The 2nd Air Division planned all of the missions for all types of fighters in theatre. However, the F-5s had slightly more flexibility in their missions because, on many occasions, they were diverted to various high-priority targets after take-off. These would include targets such as sampans, buildings, vehicles, etc. Just a few weeks after arriving at Bien Hoa, 4503rd F-5s flew a mission that most of the news media carried. In a single strike involving three aircraft, a forward air controller confirmed that 39 Viet Cong buildings were levelled, producing five secondary explosions. Squadron commander Colonel Frank Emory led the flight and stated that, "We had a good target and we made the most of it. We saw no ground activity nor did we experience any ground fire."

4503rd TFS(P)

The 4503rd Tactical Fighter Squadron (Provisional) was established at Williams AFB on 29 July 1965 as the Skoshi Tiger evaluation unit. The unit was redesignated as the 10th FCS in March 1966. Shown right is the original Skoshi Tiger patch, while below is the welcoming banner put up by the 3rd TFW shortly before the F-5Cs arrived at Bien Hoa.

In the total picture of the air war over Vietnam, the F-5 has been given little mention. They was only one squadron of 12 aircraft, involved in a war in which thousands of aircraft (all types) moved in and out of the theatre. Air Force statistics state that 5,226,701 sorties were flown in the Vietnam War and that a total of 2,257 aircraft was lost. In the period from October 1965 through 1968, the 4503rd and the 10th squadrons lost only nine aircraft (two of the losses were operational and seven were combat losses).

Viable platform

However numerically insignificant the F-5 presence in Vietnam might have been, the aircraft were in the thick of action and proved to the military community that they were a viable weapons system. Colonel Emory relates the extent of their involvement with a brief overview: "We began by flying air-to-ground operations from Bien Hoa, then we branched out and began launching strikes against supply

Left: Although many of the missions out of Bien Hoa were short-range sorties, the F-5s also flew longer raids into Laos and North Vietnam, which required aerial refuelling. These missions often involved escorting ECM aircraft over Laos or working with F-105s along the Red River.

Above: An ammunition cart carries the 20-mm rounds destined for the F-5Cs behind. The cannon proved to be a devastating weapon against vehicles and sampans. The F-5s flew many interdiction missions in an attempt to staunch the flow of war materiel entering South Vietnam, including flights into Laos.

Right: The dive attack was one of the most accurate means of delivering bombs, and was employed often by the F-5s. Operations in the South were not hampered by AAA as much as those over the North.

Above: Ordnance crewmen load a 750-lb napalm tank on to the outer pylon for the afternoon's sortie. Napalm was very effective in open country but was rarely used against targets in jungle cover. The F-5C proved easy to maintain and turn round quickly under combat conditions.

Weapons of Choice: Skoshi Tiger Test

Rolling stock and sampans	**20-mm cannon**
Bunkers/caves	**500-lb Mk 82s (low drag)**
Landing zone prep/trenches etc.	**500-lb Mk 82s (high drag)**
Troops in contact	**CBU**
Troops in contact/storage areas etc.	**Napalm**
Deep caves/large buildings	**750-lb M117 (with .025-sec delayed fuse)***

***When the old World War II-era M117s were depleted, new 1,000-lb Mk 83s were used**

An F-5C releases four M117 750-lb bombs, this weapon being used with great results against heavily fortified targets. The standard loadout was four M117s with a centreline fuel tank.

routes in Laos along with escorting electronic surveillance aircraft along the Chinese/Laotian border. Then we did some escort work with the F-105 fighter-bombers in attacks on Red River supply bases in northwest Vietnam. We also carried a lot of bombs up into this area ourselves. I might add that we did our level best to find some MiGs while in the north, but we never found one! The northern Laos routes and missions north required aerial refuelling. Most of the time we hooked up with the tankers over Laos or the Tonkin Gulf, depending on the route we were flying."

End of the year review

When 1965 came to a close, Skoshi Tiger had finished its ninth week in combat. During that time, the aircraft had flown 1,438 sorties over hostile territory and had dropped 2.89 million lb (1.31 million kg) of ordnance on Viet Cong targets while operating from Bien Hoa AB. On each sortie, the F-5s had averaged eight passes on their targets. The breakdown of ordnance delivered was 1,600 Mk 82 500-lb bombs, 1,700 750-lb napalm canisters, and over 500,000 rounds of 20-mm. All of this equated to the destruction or damage of 2,434 structures, 112 sampans, 70 trucks, two docks and 38 bunkers. These figures were all confirmed, but 40 per cent of the targets that the Tigers hit were obscured by trees and no figures were available on damage or destruction. These data are very impressive, considering that all of the work was done in the south and that good targets were scarce. Credit should also be given to the FACs, for they were the ones that located and pinpointed the targets for the F-5s. The squadron had been flying 24 sorties per day and, had it been necessary, could have easily doubled that amount. The utilisation rate was 62.5 hours per month. Maintenance required 11.9 man-hours per flying hour, barely half the estimated 21 hours.

Captain Edd Barnes, who flew 230 combat missions, related one of those experiences that involved a FAC and an early morning mission. "It seems that this FAC I was working with had been playing a lengthy game of hide and seek with a VC that was pushing a munitions-loaded bicycle. My weapons load was 750-lb canisters of napalm. The FAC described the target and the surrounding area and pointed me in the right direction. Initially, the target looked more like a black stick figure attached to two jackasses tied upside down and backwards. But, the gunsight picture correlated with the FAC's description at the release point. The ensuing secondary explosion was formidable and naturally the FAC was ecstatic. There is no telling how much munitions the VC was pushing."

First loss

On 16 December, tragedy struck the 4503rd. Major Joe Baggett, one of the flight commanders in the squadron, was killed while on a close air support mission. He was hit by intense ground fire at a low altitude. His F-5 was on fire and his wingman, Captain Jamie Denard, called for him to punch out. Baggett attempted to punch out but the rocket motor bracket on the seat failed, causing the rocket motor to spin and strike the pilot's head. A helicopter picked him up immediately, but nothing could be done to save his life. It was the only loss in 1965 for the Skoshi Tiger squadron. Squadron

VIP guests

As the only F-5 unit in the theatre, the 4503rd naturally drew much interest. Among the VIP visitors were the US forces entertainer Bob Hope (right) on one of his many tours to Vietnam, Prime Minister of Vietnam General (later Air Marshal) Nguyen Cao Ky (below right) and a high-ranking delegation from the Chinese Nationalist air force (below). General Ky, seen being shown the cockpit by Colonel Emory, was himself a pilot, and was later to check out in the F-5.

Pilots of the 4503rd TFS(P)

Above: Colonel Frank Emory was the commanding officer of the 4503rd TFS(P) throughout the Skoshi Tiger deployment.

Right: Captain N. L. Branam stands in front of an F-5 loaded with LAU-3 19-round rocket pods.

Above: The pilots of the 4503rd TFS(P) pose by one of the squadron jets at Bien Hoa. The boss, Colonel Emory, is second from right in the front row.

Left: On 3 February 1966 Captain Miles Withrow (centre) flew the 4503rd's 2,000th combat sortie. Captains James N. Denard (left) and Louis Rever (right) were also on the mission, which hit a VC troop concentration south of Bien Hoa.

Right: Lieutenant Colonel Alfred H. Hopkins was the 4503rd's operations officer. He later commanded the 4441st CCTS F-5 training unit.

statistics show that the F-5 sustained only one hit per 250 sorties. This was outstanding when compared to the F-100 operating in the same identical environment, which was hit once in every 90 missions.

Phase 2 began on New Years Day 1966 when the 4503rd moved its aircraft up to Da Nang AB. The unit was to undertake a one-month test to see how well the F-5 would perform against targets in North Vietnam. Unfortunately for this segment, a moratorium on bombing targets north of the DMZ was put in effect and this left the Skoshi Tigers with a limited number of things they could do. They were only able to fly interdiction missions against the supply trails in Laos.

Fuel problems

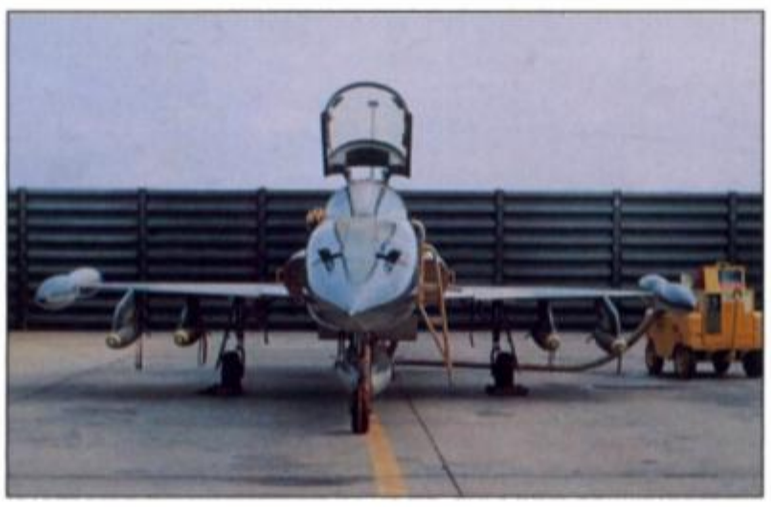
One of these missions is described by Captain James Thar: "One of the most memorable missions that I flew into Laos was a four-ship that required refuelling over the South China Sea. We flew through a line of thunderstorms into Laos to make road cuts on the Ho Chi Minh trail. We dropped our bombs on the uphill side of the road so the dirt would block the trail. Since we had enough fuel, we flew some road recce looking for truck parks camouflaged by the trees. Suddenly, I lost power on my No. 2 engine and noticed that the eyelid was stuck

For the fourth phase of the Skoshi Tiger evaluation the F-5s returned to Da Nang for out-country operations, which began on 22 February 1966. Here a four-ship refuels on its way north of the DMZ to hit bunkers.

open. The only way I could get any noticeable power from that engine was to go afterburner. There was not enough fuel for that and I told my lead, Lieutenant Colonel Georgi, that I needed to head back to Da Nang because of fuel considerations. We had to go back low (10,000 ft) because of my single engine operation. We went back through some rough thunderstorms and could not pick up the TACAN, so we dead-reckoned back to the base. I looked at my fuel gauge and it read 200 lb (91 kg) and

Above: Captain James Thar poses by an F-5C with the crew chiefs prior to launching on a mission against a Viet Cong headquarters in February 1966. The buildings were hidden in a wooded area, and the LAU-3 rocket pod was chosen for good area coverage and destructive power rather than accuracy.

Right: Armed with Mk 82 bombs, an F-5C awaits a mission in its revetment in 1967. When assigned to the 10th FCS, most of the aircraft had the refuelling probes removed.



we were in the clouds with no field in sight.

"I didn't panic, but remembered a couple of Bible verses and I felt sure that everything was going to work out. Sure enough, in seconds, I noticed a hole in the clouds right above the bay at Da Nang. We spiralled down and landed safely. I still remember it vividly to this day!"

While the Skoshi Tigers were sweating it out at Da Nang, a high-level meeting was underway in Honolulu. At this secret meeting, Air Force planners were asked to provide 10 more fighter squadrons for Vietnam and six more for Thailand, by the end of 1966. This request was coupled with others, including an increase to almost 460,000 troops. Another urgent subject discussed was the importance of the B-52s and the need to increase their number of monthly sorties. It would escalate to 450 per month in April 1966 and to 600 by July. The meeting also had a tremendous impact on the F-5 programme. It was here that the success of the Skoshi Tiger programme received enough notice that it was determined to keep the F-5s in Vietnam as an active squadron when the 4503rd went home. This would account for one of the 10 squadrons requested. (And is what caused the postponement of delivering F-5s to the South Vietnamese.)

When all of the these squadrons were put into place, by the latter part of 1966, the monthly total of sorties requested for all US aircraft in Southeast Asia would be set at 18,500.

Cluster bombs

One weapon that was fairly effective but not a favourite of the pilots was the CBU pod (SUU-7). It carried many small bomblets that would disperse and cover a wide area. This weapon was devastating against troops, especially where they were bunched up. Captain Bob Terbet comments on the weapon: "Early on, as we experimented with different ordnance loads, there is one mission that comes to mind. I was configured with CBU canisters and napalm. After the strike it was procedure to dump the canisters in the Saigon River. Flying very low at

A Skoshi Tiger F-5C heads out on a low-level mission against troop concentrations, carrying napalm tanks and Mk 82 bombs. The latter are fitted with the Snakeye retarding tail, which allowed them to be delivered at low altitude without 'fragging' the aircraft.

Skoshi Tiger Project

23 October 1965 to 9 March 1966

Missions	825
Sorties	2,664
Aborts	42

Ordnance Expended

20-mm	614,193 rounds
BLU-1B	2,295
LAU-3	259 pods/4,918 rounds
Mk 81	70
Mk 82	2,210
Mk 83	4
M117	3,212
GP bombs (total)	5,496

Strike results

	Destroyed	Damaged
Structures	1,963	1,713
Sampans	105	55
Fortifications	181	
Trucks	7	
Bridges	8	
Barges	3	

Secondary explosions	77
Mission results unobserved	313
Battle damaged aircraft	16
Aircraft losses	1

Above: Lugging four M117s, an F-5C waits to taxi to the last-chance point, where the safing pins in the weapons will be removed prior to take-off. Note that the intake covers are still fitted.

Right: This January 1966 mission was aimed at Viet Cong troops using houses for protection. The photograph was taken from the second F-5 as it dives into its target, the first having already launched its 2.75-in rockets.

450 kt, I jettisoned the CBU canisters; immediately thereafter, the aircraft became very difficult to control. My first thought was that some bomblets exploded. I looked at the wings and, to my surprise, both leading-edge flaps were missing as well as the front part of the tip tanks! My wingman pulled up alongside me and told me that there were no visible fuel or hydraulic leaks, so I proceeded back to base. There were some wide eyes in the de-arming area after I landed. It was discovered that incorrect charges were installed in the pylons carrying the CBU. (Load info was sent to us from Edwards AFB.) Rather than a down-and-away trajectory, the canisters were blown over the wing. They also struck the right slab, which damaged the right afterburner." Several pilots reported that when they dropped this weapon at low level, they could not do any jinking because it could have caused the bomblets to blow up while still attached to the aircraft.

Tube-launched bomblets

Another Skoshi pilot, Major Edd Barnes, comments on the cluster bomb units, or CBU-2/A. "Each white canister had, as I recall, an odd number of tubes (19 comes to mind). Each tube was loaded with individual bomblets, usually BLU-3 fragmentation weapons. Each

This F-5C is seen at Bien Hoa during the third phase of Skoshi Tiger. The evaluation proved beyond all doubt that the F-5 could play a useful part in the Southeast Asia war, but it was denied its chance to gain importance by political decisions regarding the aircraft's position in the USAF. The in-country role it would have played was largely entrusted to the venerable F-100, which in the event performed uncomplainingly for nearly eight years, albeit with heavy losses.

Above: A pair of F-5s returns from a January 1967 mission near Bien Hoa. Even with centreline and tip tanks carried on most sorties, the F-5 often needed aerial refuelling even on in-country tasks.

Right: By the time the F-5s arrived in Vietnam, the parking areas were protected by steel revetments. While these could do nothing against a direct hit from a VC mortar, they could contain the damage to one or two aircraft.

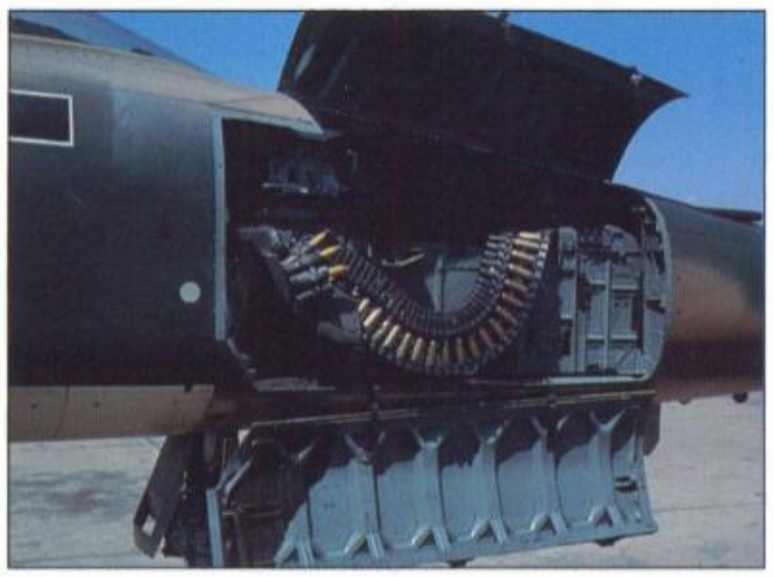
Below: Seen parked at Bien Hoa is a vital piece of squadron equipment – the commander's Jeep.

bomblet packed an unbelievable wallop. There was no way of knowing when a CBU pod was empty except that it failed to dispense bomblets when the release button was depressed, and there was no guarantee even then that there wasn't a bomblet or so hung in the pod. Therefore, once dispensing had been initiated, we did not return to land carrying a pod/canister. Usually we jettisoned the pods in the target area or some other designated spot. Intelligence briefings always included the co-ordinates of jettisoned pods. Restricted run-in headings were the rule rather than the exception when dispensing CBU, because troops in contact was a frequent target, and short bombing runs require numerous bombing runs. Almost always, the runs were from the same direction, same speed, same altitude and with an off target break in the same direction, so as not to overfly the friendlies. The CBU was a very effective weapon, but always tricky to deliver."

On 9 March 1966, the original Skoshi Tiger project came to a close. It had been far more successful than had been anticipated. They had flown two 'in-country' phases and two 'out-country' phases. The missions flown out of Bien Hoa had generated 2,093 sorties, while the missions out of Da Nang AB had produced 571 sorties, giving the 4503rd a total of 2,664 sorties and 3,116 combat hours. The Pentagon was already aware of how successful Colonel Frank Emory and his squadron had been. Orders were cut to keep the F-5 in action in Vietnam. The 4503rd's business was concluded and the 10th Fighter Commando Squadron would continue the mission. The 10th would officially take over

F-5 ordnance

Napalm was carried in 750-lb (340-kg) BLU-1 canisters. They were found to be more effective without the optional fins fitted here.



This is the belt feed for the starboard Colt-Browning M39 20-mm cannon. Firing the cannon occasionally resulted in smoke in the cockpit.

Armourers load 2.75-in (70-mm) FFARs (folding-fin aircraft rockets) into an LAU-3 19-round pod. Various warheads were available.

The Mk 80 series bombs were more streamlined than previous weapons, with greater kinetic energy. These are 500-lb (227-kg) Mk 82LDGPs.

Captain Gil Dunne stands with his crew chief in front of 64-13332, which carries BLU-1 napalm canisters and M117 750-lb (340-kg) bombs.

MERs (multiple ejector racks) were occasionally carried in place of the fuel tank. This MER carries six 250-lb (113-kg) Mk 81s.

the operation at Bien Hoa on 8 April 1966.

Air activity over North and South Vietnam increased significantly. For the entire year of 1965, a total of 144,000 sorties had been flown. By 30 April 1966, the total sorties had already reached 97,000. By the end of 1966, there were 834 military aircraft in Vietnam and another 415 in Thailand. The F-100 was still most numerous, with 203 aircraft, and the F-105 was operating from Thailand with 135 aircraft.

The North Vietnamese did not have the luxury of using an indigenous railway system in the south, because they did not control the territory. In turn, they had no way of resupplying their army by air, because their air force was not even a minute factor south of the DMZ. This left only the rivers, roads and jungle paths. It was crude, at best, but sheer manpower accomplished much in this situation. They did have the opportunity to move freely in areas with dense jungle foliage.

A pair of F-5Cs taxis out for a May 1967 mission, each armed with four Mk 82LDGP (low-drag general-purpose) bombs. This was the last month of operations for the 10th Fighter Commando Squadron before the aircraft were handed over to the Vietnamese.

Sampan attack

One mode of transport against which the F-5 performed well was the sampan. This type of target moved slowly and carried a significant amount of war supplies. According to Major Dick Williams, "There was only one weapon of choice on this target and that was the 20-mm cannon. The rockets that we carried were just about useless because they were so erratic. If they had a small ding in the fin or one was slightly bent they would go off in any direction, but I will say that all of those 2.75s being fired would scare the hell out of anybody." During the four months the 4503rd was in Vietnam, their records show that they destroyed 105 sampans and damaged another 55. Most, if not all, of these were chewed up by the F-5's 20-mm cannon.

Perhaps some of the most important traits of the F-5 were manifested more obviously on the maintenance side. The squadron always achieved a very high in-service rate and the ease with which any repair work was done showed in the log books kept by the ground crews. For example, on 7 March 1967, the rate was at 94 per cent. There were eight write-ups ranging from engine idles high, VHF garbled, nose gear steering is stiff to ground, abort due to high oil pressure in No. 1 engine (no mission lost/late take-off). Two days later, on 9 March, the squadron had a rate of 99 percent with only one write-up, a No. 1 engine vibrating.

Equally astounding is that right after the 4503rd squadron had begun operations out of Bien Hoa, its maintenance people set a new record for changing both engines, of 2 hours and 20 minutes (17 January 1966). The F-5 used the extremely reliable General Electric J85 engine. In the early spring of 1966, about the time that the 10th FCS was assuming responsibility for the F-5s, these same engine specialists set a new speed record with both engines changed in 1 hour and 55 minutes. This includ-

Pilots of the 10th

Above: Captain Swart Nelson (left), Lieutenant Colonel Bill Mol (centre) and Major Gil Dunne (right) join hands after a mission right at the end of the 10th's Vietnam service.

Above: Captain Jim Martin awaits a mission in October 1966.

Right: Major Dan Hogan climbs out of an F-5C at the end of an April 1967 mission.

Above: A few of the 10th FCS pilots take time out for a group photo. On the far left is the squadron's operations officer, Major Dick Williams.

Major Harv Kimsey prepares for a mission. All of the pilots wore the tiger-striped helmet.

Above: Three F-5s and an F-104 are seen behind a KC-135A during a Pacific crossing. Flying the F-5s are Major Edd Barnes (left), Lieutenant Colonel Robert Titus, 10th FCS commander (centre) and Captain Don Nelson (right). All had taken a few days out from combat operations to ferry replacement aircraft from the US.

Left: Six F-5s, newly arrived from the US, await their first combat missions in the hands of the 10th FCS in May 1967, immediately prior to being handed over to the VNAF's 522nd FS.

10th FCS

In March 1966 the 4503rd TFS(P) was redesignated as the 10th Fighter Commando Squadron, part of the 3rd TFW at Bien Hoa. Its aircraft were handed over to the VNAF's 522nd Fighter Squadron in April 1967.

ed the maintenance officer taking the aircraft for a test flight.

For the period of 23 October 1965 to 17 April 1967, while the USAF was operating the F-5 in combat, the sortie rates per aircraft ranged from 1.4 to 2.0 per day. During some peak periods, the rate ran as high as 4.0 sorties per day for each aircraft. Squadron records also mention that one crew chief's F-5 flew 35 straight sorties without a single write-up from the pilot. The level of professionalism displayed by both the pilots and the ground crews proved to be the F-5's biggest asset, and was a key factor in its success in combat.

F-100 rival

As mentioned earlier, the F-5 was not in the same class as the F-105 and F-4. It could not carry the payload, did not have the speed and, above all, it was not equipped to defend itself deep in North Vietnam, especially against SAMs. But, it was every bit the equal of the one fighter that was used in the greatest numbers – the F-100.

Lieutenant Colonel Jim Porter gave his analysis of this comparison, echoed by all of the Skoshi pilots: "There were many opinions floating around about the value of the F-5 as a combat aircraft. It was often compared to the F-4 and, of course, found wanting. It was not even the same animal. It did compare favourably with the F-100. It could do everything the Super Sabre could do except stay as long over the target. Payloads and take-off distances were pretty much the same. Northrop had a mod which would put additional fuel in the dorsal fin area. This would greatly increase its ability to remain over the target.

"Another mod, a nose-jack, would have placed the attitude of the wings at a flyable angle of attack from the outset of the take-off roll. The roll distance would then have been about one-half. In my opinion, if these modifications could have been completed before the tests ended, the aircraft would have turned a lot of heads."

Six months into the 10th Fighter Squadron's operations in Vietnam (October 1966), it was announced that 33 officers from the VNAF had been selected and had reported to Williams AFB, Arizona to begin training in the F-5. They would form the original cadre from the VNAF 522nd Fighter Squadron that would first get the F-5. Most of this group had logged hundreds of hours in the A-1 Skyraider, so they had a very high level of combat experience. A

Wing surfaces
The tiny wing featured full-span leading-edge flaps of 12.3 sq ft (1.14 m²) area, small ailerons and trailing-edge flaps of 19.0 sq ft (1.77 m²) area.

Armament
This F-5C is carrying a standard anti-personnel load of four BLU-1 napalm tanks. Although nominally classed as a 750-lb (340-kg) weapon, each canister actually weighed 874 lb (396 kg). Occasionally they failed to separate cleanly, hitting the underside of the wing.

Maintenance
The F-5 was designed with ease of maintenance as a major factor. The entire rear fuselage, complete with tail, could be removed for rapid access to the engines, while the hydraulic pump, generator and engine-driven gearbox comprised a single packaged component.

Fuel
Internal fuel was carried in two tanks in the main fuselage, with a combined capacity of 583 US gal (2207 litres). The F-5C always carried the 50-US gal (189-litre) wingtip tanks, which featured a characteristic area-ruled shape. The 150-US gal (568-litres) centreline tank was usually fitted for all but the shortest of missions, when it was occasionally replaced by an MER with up to six bombs.

F-5C modifications
The initial Skoshi Tiger aircraft were four FY63 and eight FY64 machines taken from F-5A production. Modifications for USAF combat service included the fitment of 198 lb (90 kg) of belly armour for protection, four jettisonable underwing pylons, inflight-refuelling probe and night formation lights. The rudder travel limiter was removed, and the standard Norsight fixed optical sight was replaced by a lead-computing gunsight. Dual platform gyros were installed for better instrument flying standards and other avionics items were improved.

Northrop F-5C-NO-20
10th Fighter Commando Squadron
Bien Hoa AB, SVN

The 10th FCS continued the combat operations of the 4503rd TFS(P) for just over a year. During this time the unit underlined the fact that the diminutive F-5 could perform the in-country attack mission as well as the F-100, although it lacked the endurance to spend much time over the target.

Mission tally
Most of the Skoshi Tiger aircraft carried individual sortie tallies on the nose, and these scoreboards grew to sizeable proportions as the aircraft sometimes flew up to four times a day, although one or two was more normal. This aircraft, 64-13332, was the high-timer aircraft on the unit.

Reconnaissance nose
The RF-5As supplied later to Vietnam had a camera nose containing four KS-92 cameras with a variety of lenses. They could be arranged to give trimetrogon and split vertical coverage in addition to standard oblique and vertical photography.

Powerplant
Power for the F-5C came from a pair of General Electric J85-GE-13 turbojets, each of 4,080-lb (18.1-kN) thrust. Additional air for low-speed operation was provided through louvre doors in the rear of the fuselage.

Above: Only a few minutes after take-off, these 10th FCS F-5s are already lining up for an attack. Some targets were as little as 15 minutes' flying time from Bien Hoa. The F-5s worked regularly with forward air controllers (FACs).

Right: Major William H. Gillette was the first F-5 pilot to log 500 hours, and he did so while on a combat mission. On the right is crew chief TSgt Haywood Cormier and on the left is Major Dick Williams.

few weeks later, VNAF airmen and non-commissioned officers would report to receive instruction in maintenance of the aircraft. The 4441st Combat Crew Training Squadron would conduct the courses and the USAF instructor pilots who would teach them were all veterans from the original Skoshi Tiger project. The 4441st squadron commander was Lieutenant Colonel Alfred Hopkins, who was the first pilot to land at Bien Hoa AB in the F-5, back in October 1965. Each VNAF pilot would receive a minimum of 55 hours' flying time before being considered for graduation. By the standards used for training other user countries, the 55 hours was light, but, given the experience of these VNAF pilots, it proved to be more than sufficient.

Left: F-5s from the 10th FCS work over a camouflaged truck park just off a road in September 1966. The size of the explosion denotes the use of 750-lb M117 bombs.

Below: Loaded with 'nape', an F-5 awaits its pilot. The tanks in the foreground are BLU-27s.

Flying as art

A press release dated 27 September 1966 stated that six months after the 522nd Squadron (VNAF) received its F-5s, another squadron would be formed with approximately 20 additional F-5s. This would put the VNAF's strength at more than 400 aircraft, most of which were propeller-driven A-1 types. One of the instructor pilots from Williams AFB said that, "The South Vietnamese pilots do not fly the same way as the Americans. The USAF

10th Fighter Commando Squadron
8 April 1966 to 17 April 1967

Flying hours	7,537
Sorties	7,321
Abort	85 (air 3, ground 82)
Ordnance expended	
20-mm	778,566 rounds
Mk 81	1,950
Mk 82	9,639
Mk 83	no record
CBU-2A	8,75
Napalm	9,777
Aircraft losses	8
Aircraft battle damage	17

4441st CCTS

The 4441st Combat Crew Training Squadron was established at Williams AFB in December 1963 to provide air and ground crew training for F-5 export customers, the initial class consisting of US MAAG, Iranian and South Korean pilots. In August 1966 the squadron began training VNAF pilots. In October 1969 the unit was redesignated the 425th Tactical Fighter Training Squadron.

considers flying fast jets to be a skill, and the Vietnamese consider it to be an art. They will have to go more toward standardisation as they move into the more sophisticated jets."

As a side note, in FY 1966 around 240 South Vietnamese pilots were trained in the United States to fly fighter-bombers, twin-engined transports and helicopters.

Regardless of the mission of a fighter aircraft, there has always been a gleam in the eye of its pilot, ready for a shot at an enemy fighter. Although the F-5 was never put in a position where it could take on a MiG, the pilots never lost hope. On several occasions they flew MiG-CAPs. The aircraft were armed with two Sidewinder missiles, for which the 50-US gal (190-litre) tip tanks had to be removed. Captain Bob Terbet commented, "I believe that if we had had the opportunity to take on the MiG-21, we would have come out pretty well as long as we could have held them down to the lower altitudes. I have always strongly believed that the pilot usually determines the outcome, and our guys were very good!" This statement can be supported with many solid arguments, including the fact that the F-5 is still being used today as an aggressor aircraft and fights against the F-15, F-16 and F/A-18.

Photographed in 1969, this F-5 is from the VNAF's 522nd FS. The checkerboard marks on the rear fuselage were the wing markings of the 3rd Air Division to which the 522nd was assigned.

Lethal AAA

A far more dangerous threat to the low-flying F-5s than any MiG was the Viet Cong's extremely lethal Quad-50 machine-guns. Major Dick Williams, who flew as many or more combat missions in the F-5 than any other pilot (303 missions), recalled a very costly and dangerous mission. "This started out as a routine mission with four F-5s. Captain Clyde Johns was on my wing. Right after we took off, No. 3 had to abort, as he had lost an engine. The pilot was Captain Bill Gillette (the first pilot to log 500 hours in the F-5). He was carrying two 750-lb napalm canisters on the outboard pylons and two 750-lb GP Mk 83s on the inboard. I ordered him to drop his ordnance, but he tried to make it back to base. He tried to turn final but slid in about 2 miles short of the runway at Bien Hoa. The ordnance did not explode and he was able to get to the aeroplane and evade the Viet Cong. A company of US infantry was able to get to him in time. This left Johns, who was leading, and myself to continue the mission down into the delta. Gillette's wingman accompanied him back to base.

"We proceeded to the target area, which was approximately 160 miles south/southeast of Saigon, next to the Mango swamps. We were to hit the HQ of a VC unit, which reportedly had 10 or 11 Quad-50s defending it. As it turned out, we counted 20 of them. We proceeded to take out 18. Johns got hit on his next to last pass ... I called to him that he was on fire, but his instruments were telling him that he had no fire. There was a ball of flame stretching about 2,000 ft behind him. He tried to gain

This VNAF F-5A is carrying finned napalm tanks. The fins tended to guide the canister straight into the ground, whereas the unfinned tanks tumbled, providing much greater area coverage when they split and ignited.

522nd Fighter Squadron

The 522nd FS was formally activated as the first VNAF F-5 squadron on 1 June 1967, although the unit had already formed to begin operations on 17 April. It remained the only VNAF F-5 squadron until the large Enhance and Enhance Plus shipments, and it frequently operated on detachments from its Bien Hoa base. The 522nd was assigned to the 23rd Tactical Wing, part of the 3rd Air Division.

some altitude and made it up to about 2,100 ft. I had pulled up off his wing and counted more than 20 bullet holes in his aircraft. By this time, the fire was creeping up his fuselage and had engulfed his vertical and horizontal stabilisers. He still was not convinced that he was on fire until I told him to look in his rear-view mirror. Within seconds, he had pulled the lanyards and ejected clear of the fireball. He landed right in the middle of a rice paddy that had just been fertilised with human waste. He was not happy, and it was tough to get him to stay low when I spotted the Viet Cong trucks headed his way! I made a firing pass over the vehicles to slow them down. About that time, four VNAF A-1 Skyraiders came into the area and offered to help. Not far behind them were two helicopters. Two of the A-1s were shot down by the Quad-50s, and their pilots ended up in the same paddy. A flight of four F-100s launched from Bien Hoa to give us a hand and, when they arrived in the area, two of them were shot down by the 50-calibre fire. Now, we had five pilots in the same paddy.

"However, the helicopters got in and rescued all of them. It was at this time I realised my fuel was so low that I could not get back to base, so I landed at Vung Tau, which was a small strip of only 4,200 ft. Fortunately, there was an F-5 maintenance crew there that had been changing tyres on two F-5s. I had damaged my tyres on landing, so I got new tyres and fuel and took off again for the target area that had the Quad-50s. I caught a large number of Viet Cong going over the wreckage of the F-5 and my 20-mm produced a significant body count."

Vietnamese hand-over

The 10th Fighter Commando Squadron officially ended its operations in Vietnam on 17 April 1967, although missions were still being flown into May. The South Vietnamese 'officially' took over all F-5 operations in Vietnam on 19 June 1967, in a formal ceremony held at Bien Hoa. The 522nd Fighter Squadron (VNAF) became the first squadron to fly combat in the Freedom Fighter. Eventually, the VNAF had four squadrons of F-5s, all of which were under the command of the 23rd Fighter Wing. As more and more training classes graduated from Williams AFB, the numbers of aircraft and sorties grew. By December 1967, they had logged 527 sorties and 556 flying hours. These figures indicate that each sortie was lasting slightly over one hour, which means that most of their missions were relatively close to Bien Hoa.

Lieutenant Colonel Dexter Martin was an advisor to the 522nd Squadron and was no stranger to combat, as he had flown B-26s from Pusan during the Korean War. Colonel Martin

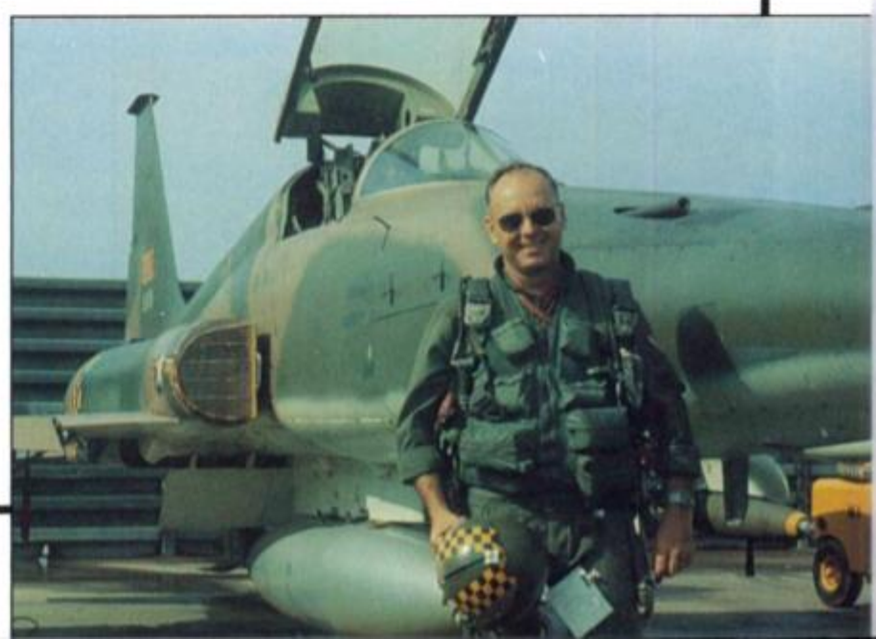
The Advisors

Right: Lieutenant Colonel Janeral Holley awaits start-up in a VNAF F-5. Although termed 'advisors', the USAF personnel flew many combat sorties with the 522nd FS.

Below: This group contains the 'top brass' of the 522nd FS, consisting of, from left to right, Captain Ghi, Lt Col Duong-thien-Hung (commander), Lt Col Holley (USAF advisor) and Major Vu (operations officer).

Above: Lieutenant Colonel Dexter Martin (above, second from right) and another USAF advisor pose with two VNAF pilots prior to a four-ship mission. Behind are the badges of the 23rd Tactical Wing's constituent squadrons.

Below: Lt Col Martin flew numerous combat missions while advising the 522nd. The F-5B two-seater proved useful for the USAF pilot to instruct his Vietnamese pupils.



This was the operations building for the 23rd Tactical Wing at Bien Hoa, from where the 522nd operated. Three further F-5 squadrons were established here in the early 1970s.

reflected on some of the missions that he flew with the VNAF. "In the area we were flying, there was little or no effective ground fire ... mostly small arms. Of more concern was the weather; rain squalls, clouds, etc. We were 'eyeball' bombers and had to have visual contact with the ground and target area. We had to have our FAC in sight and he had to be able to see us. The only time I was ever hit by ground fire was when I was on a low-level, camera reconnaissance mission south of Saigon. I was hit in the centreline fuel tank, probably from someone firing a rifle straight up. At the time, I was running down a small river where there was some boat traffic. I was not aware of the hit until I was back at Bien Hoa. There were a lot of aircraft brought down during the war by small arms fire.

Across the border

"On one occasion, we were to fly a mission into Cambodia. At this time, the Vietnamese had attacked Cambodia. We were scheduled for missions out of Bien Hoa at one-hour intervals. We always flew a three-ship formation. I do not recall the reasoning behind this, but I guess if a two-ship had an abort, the mission would have been scrubbed. In this way, the remaining two-ship would go on and complete the mission. However, with the F-5, having to abort a mission was never a problem! This mission was to a village in Cambodia where there were streets and buildings. These represented real targets,

Above: Four Vietnamese pilots pose in front of a Cambodian MiG-17. Another MiG and an F-5 are visible in the background.

Unusual visitors

Below: These Cambodian MiG-17s visited Bien Hoa when the Chinese Communists cut off their ammunition supply. The 3rd TFW was tasked with rerigging the pylons to take US weapons. They remained strictly as bombers, as there was no easy remedy for the lack of 23-mm cannon armament.

which were extremely rare in SEA.

"Most of the time, the targets were under the jungle canopy and all we were able to see was the smoke that the FAC had used to mark the target. On this particular target, we could see people moving around and the effects of the bombs on the buildings. We followed up the bomb drop with our 20-mm. Our ordnance was delivered with precision, so the FAC was happy. For some reason or another, ground fire was minimal. We all returned to base to get ready for the next mission."

With the exception of the brief forays out of Da Nang AB, the missions of the F-5 were relatively predictable. Most of the damage and destruction that the little fighter wrought was in-country, with a significant percentage within a 75-mile (120-km) radius of Saigon. They stayed busy because they were the FACs' striker of choice. To a man, all the F-5 pilots –

Right: A dramatic shot from the cockpit shows an F-5 coming in low for a napalm drop. The white smoke is from the 'Willie Pete' (white phosphorus) rocket fired by a FAC to mark the target.

Below: Operating out of Bien Hoa in 1969, this F-5A carries four Mk 82 'slick' bombs.

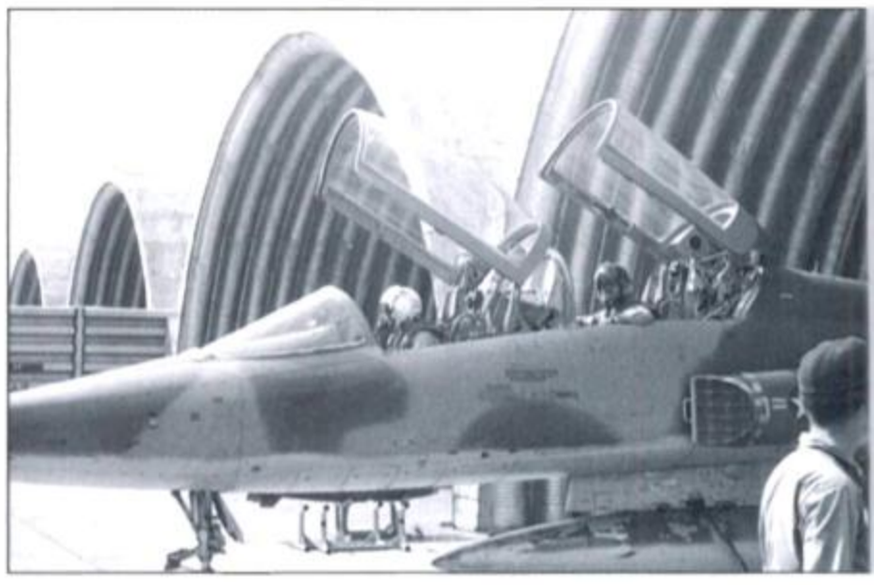
***Above:** A fine study of one of the 522nd FS aircraft in its revetment. The first batch of aircraft were simply those F-5Cs assigned to the 10th FCS transferred to the Vietnamese. Later, many standard F-5As arrived to augment the fleet.*

***Left:** This is the scene from the back seat of a VNAF F-5B as Falcon flight taxis out for a mission in September 1968. The seat was occupied by Major Curtis Burns, advisor to the 522nd Fighter Squadron.*

American or Vietnamese – stated that the one mission that got their adrenaline pumping the most was the call of "friendly troops in contact, need help." Janeral Holley, an advisor to the VNAF with over 200 combat missions in the F-5, summed it up. "The missions that stick in my mind after all these years were those in which there were troops in contact and the FAC was expressing his concern on the air. The F-5 was quick to respond and was very accurate with its ordnance. On many occasions, we were complimented by both USAF and VNAF forward air controllers. It was a great feeling to know that we made a difference."

The mystique of air-to-air combat was missing from the mission logs of some pilots, but the widespread positive results were there and, after all, that was what their job was about. There were entries that noted such things as five bunkers destroyed, three damaged, three sampans sunk, five damaged, six structures destroyed, numerous enemy troops killed or wounded by various ordnance. Every few missions would describe a devastating secondary explosion that they had caused. The 20-mm firepower must have been awesome against the wooden sampans.

By January 1975, Northrop records show that approximately 160 F-5As had been shipped



***Above and left:** The F-5B two-seater lacked cannon but otherwise was fully combat-capable. USAF personnel often occupied the rear seat, from where they could direct the operations of the F-5 flight.*

Vietnamese F-5s

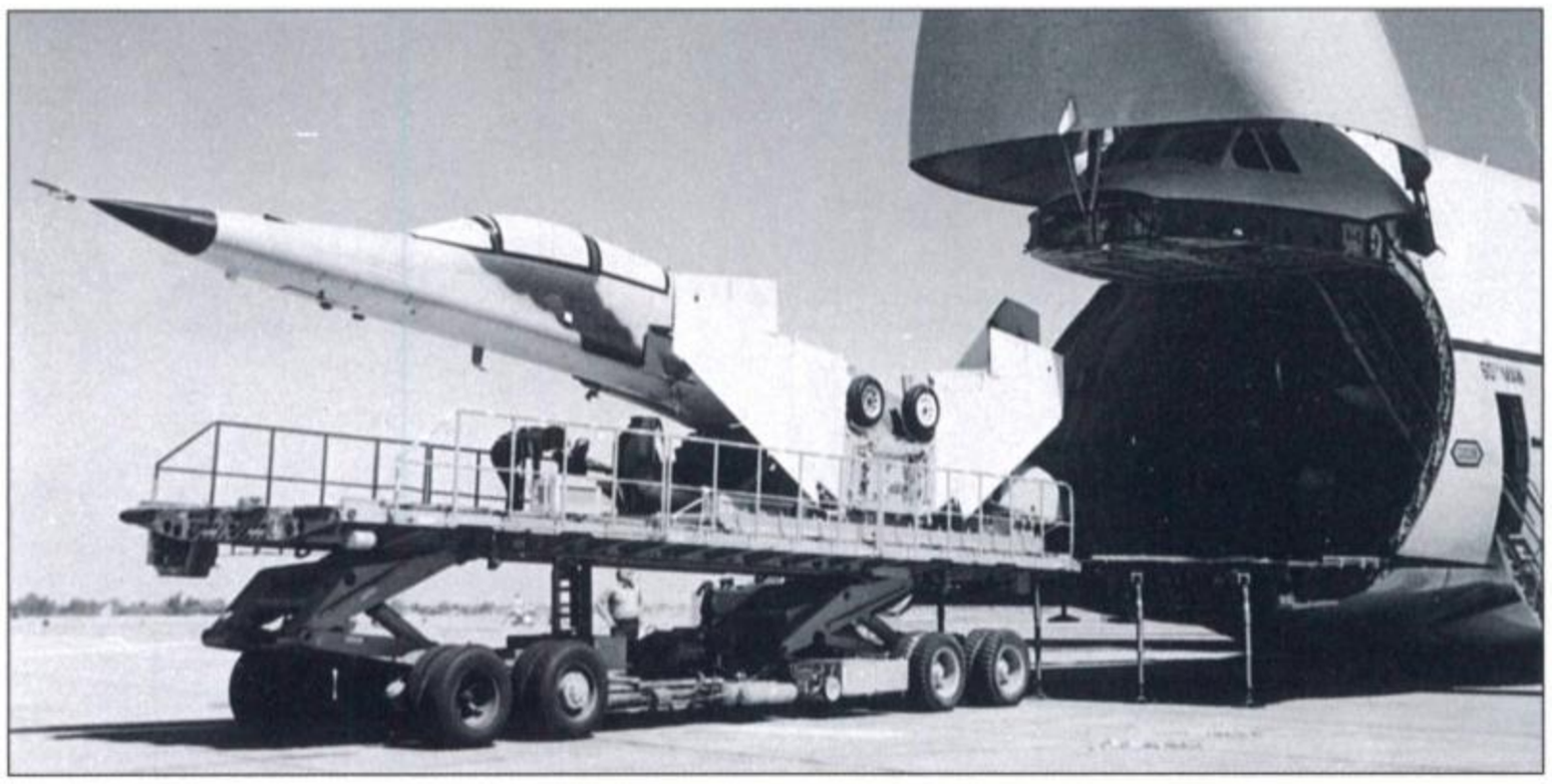
The VNAF's 522nd TFS began flying the F-5 in 1967, the initial batch of 30 aircraft transferred from the USAF comprising the following:

F-5A – 63-8428, 64-13314, 64-13315, 64-13317, 64-13318, 64-13332, 65-10513, 65-10514, 65-10515, 65-10518, 65-10524, 65-10525, 65-10526, 65-10546, 65-10547, 65-10555, 65-10556, 65-10557, 65-10558, 65-10560, 66-9129, 66-9130, 66-9131, 66-9139, 66-9140, 66-9141
F-5B – 65-10586, 65-13074, 66-9231, 66-9232

Over 100 further F-5A/Bs followed during Operation Enhance/Enhance Plus in 1972/73. These deliveries included several RF-5As, which retained the two 20-mm guns and also had a camera nose section containing four 70-mm cameras. The RF-5A retained all of the combat capabilities of the F-5A. F-5A/Bs served with the 23rd Tactical Wing (522nd, 536th, 542nd and 544th Fighter Squadrons) at Bien Hoa, 41st Tactical Wing (532nd and 538th Fighter Squadrons) at Da Nang and the 82nd Tactical Wing (540th Fighter Squadron) at Phu Cat. Some RF-5As were believed to have been flown by the 716th Reconnaissance Squadron at Tan Son Nhut.

Following Operation Enhance Plus, an estimated 118 F-5Es were delivered, rapidly diverted from other contracts (including some desert-camouflaged Iranian aircraft). The 536th FS was the first unit to re-equip, officially converting on 10 June 1974. In the course of the final offensive by the North Vietnamese in March/April 1975, 26 F-5s escaped to Thailand, one defected to the North after attacking the presidential palace, and others were captured. The North Vietnamese forces acquired 87 F-5A/Bs and 27 F-5Es which were used by several composite units, although the survivors were eventually concentrated in the 935th Fighter Regiment at Da Nang.

Most of the F-5s rushed to Vietnam in 1972/73 were delivered by the cavernous Lockheed C-5 Galaxy. Partially disassembled, the Freedom Fighters were then mounted on pallets, along with crated components, so that they could be loaded straight onto the Galaxy as one unit (below). The photo right shows aircraft waiting for transport.



A handful of RF-5As were supplied during the major re-equipment of the VNAF, these retaining cannon and full combat capability but also featuring four KS-92 cameras in the nose. These were usually arranged as a fan of three and one facing obliquely forward.

to Vietnam, 55 of which were lost in combat. Of the five F-5Bs, only one was lost. Six of the 10 RF-5As were lost.

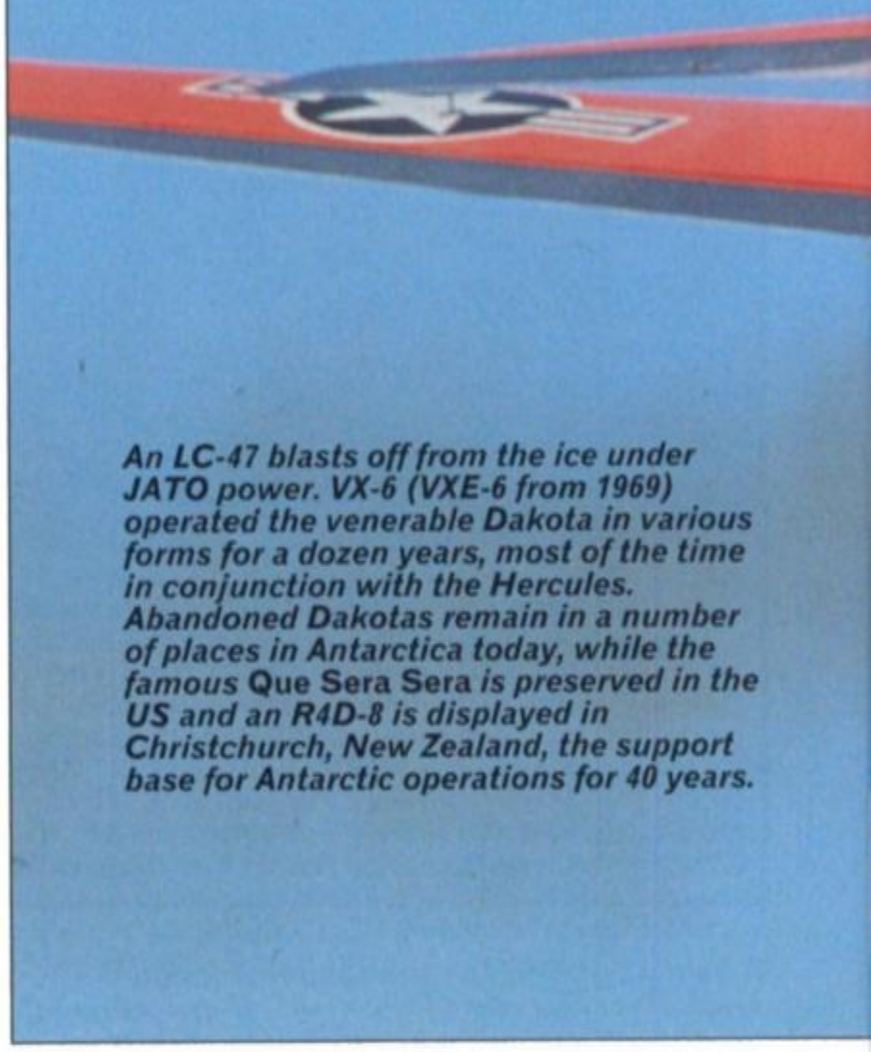
One of the most successful eras of aviation came to an end on 16 January 1987, when the final two F-5s built by Northrop under the US government's Foreign Military Sales programme rolled off the line. A total of 2,610 F-5s was produced over a 24-year period and were a vital part of the air forces of 20 countries, plus the United States. **Warren Thompson**

Postscript – *Sometime after the war in Vietnam ended, Lieutenant Colonel Dick Williams was in Malaysia when it received F-5s from the United States. The country had ordered 65 aircraft, which were flown to Malaysia in five C-5 transports. He was standing on the ramp as the C-5s came into the landing pattern. Williams asked the Malaysian air force chief of staff why they had not ordered any ground support equipment for the F-5. There was no direct answer. About one hour after the C-5s had landed, some large Soviet transports arrived. They were carrying ground support equipment for the Malaysian F-5s. It was all crated, and on the yellow instruments inside the crates was stencilled 'Skoshi Tiger'. It was all F-5 equipment that had been captured when Vietnam fell. The Malaysians had bought it from the North Vietnamese and it had been delivered by the Russians.*

This pair of F-5As is from the 522nd FS. After the USAF pulled out of Vietnam in 1972, the F-5 became the most important type in the VNAF inventory, with seven squadrons formed. By the time of the fall of Saigon in 1975, three squadrons had upgraded to the F-5E.

Above: Looking very forlorn, as if lost on an endless sheet of paper, is a VXE-6 LC-130R. This Hercules came to grief on the Nimrod Glacier in December 1984 when it hit a crevasse during take-off. Note that at least one propeller was torn off as the aircraft slewed across the snow. As often happens, the weather conditions worsened before help arrived and the crew had to set up survival tents while awaiting rescue, a wait that can sometimes last days. On several occasions, additional aircraft have been lost on searches. Too valuable to abandon, the C-130 was repaired on site and returned to service.

Below: The first aircraft to land at the South Pole itself was R4D-5 Dakota Que Sera Sera, piloted by LCdr Conrad Shinn and Cpt. William 'Trigger' Hawkes. The expedition was led by the Operation Deep Freeze I commander, Admiral Dufek, who became the first American to stand at the South Pole. The crew of Que Sera Sera nearly remained at the South Pole when the aircraft froze to the ice; it could only be freed by firing 13 JATO bottles. The Dakota wallowed through the air close to stalling, with the windscreen fogged by the pilots' breath, but gained speed and returned safely to McMurdo.



An LC-47 blasts off from the ice under JATO power. VX-6 (VXE-6 from 1969) operated the venerable Dakota in various forms for a dozen years, most of the time in conjunction with the Hercules. Abandoned Dakotas remain in a number of places in Antarctica today, while the famous Que Sera Sera is preserved in the US and an R4D-8 is displayed in Christchurch, New Zealand, the support base for Antarctic operations for 40 years.

Antarctica is the remotest, driest, coldest land mass on earth, but also an area of great scientific value and potentially huge mineral wealth. With no infrastructure of land routes, the only way of exploring the continent has been by air. Since Operation Deep Freeze I in 1955, the frozen continent has been systematically mapped and explored, with the aircraft of the US Navy's Antarctic Development Squadron Six always to the fore. The unforgiving climate and terrain, however, is hard on personnel and machines and it is no surprise that VXE-6 aircraft carry a placard with the legend 'Antarctic flying is hours of sheer boredom interrupted by moments of stark terror'.

Right: The helicopter has been vital in supporting efforts in Antarctica since seven Sikorsky HNS, HOS and HO3S machines participated in Operation High Jump in 1946-47. In 1959 VX-6 was assigned all four of the HUS-1L winterised variant of the Sikorsky Seabat for logistics and science support flights. By 1970, when '4' (with one nose door from '3') was seen landing at Scott Base, the type had been redesignated LH-34D.

On Ice

Military Aviation in Antarctica

Antarctica

The USN purchased four DHC Otters with the designation UC-1 in 1955 for use by the newly-formed VX-6. The aircraft seen here, 142427, suffered a cracked fuselage when taxiing between scientific sites in October 1958. The Otter was flown back to McMurdo but was declared a write-off. Sister ship 142426 was blown away by an 80-mph (130-km/h) gale in 1957 and 142424 was abandoned on an ice floe after a crash in 1955. More Otters were acquired from a later batch and several of these were also lost.

Below: As part of Deep Freeze III, Detachment 30 of HU-1 operated from the icebreaker USS Atka with two helicopters. On 1 December 1957, the HUL-1 (right) crashed on deck and caught fire, subsequently being pushed overboard. Two days later, the HO4S-3 crashed on the Ross Ice Shelf, fortunately also without injury.

Right: With the loss of Atka's helicopters, an HUS-1L of VX-6 was lent to the ship so that supply flights to the Little America V base could be completed. Note the skis, and the flotation bags mounted on the fuselage side.

Below: US Antarctic operations are centred on the Ross Dependency, which is the part of Antarctica administered from New Zealand. Seen landing at New Zealand's Scott Base during the 1962/3 season is a CH-19E (until April 1962 an HRS-3) of HU-4, one of the units with detachments on icebreakers that season.

Above: Originally acquired as trainers, the HTL-7 – a Navy version of the Bell 47K Sioux – later operated off Antarctica. The HUL-1 was a four-place Sioux variant, also with enclosed cockpit and tailboom and also used from icebreakers.

Right: One of the first fixed-wing aircraft to be operated in Antarctica was a winterised version of the P2V Neptune. Four P2V-7s (the final production version, with underwing jet pods) were converted during production for VX-6 with skis and JATO rockets. Armament and patrol equipment were removed to make room for survey and photographic equipment and a bomb bay fuel tank. Together with C-54 Skymasters, Neptunes made the first landings in Antarctica by aircraft flown from another land mass (New Zealand) in December 1955. 140434 was destroyed in California on an acceptance flight in 1958 and 140439 in a take-off accident at Wilkes Station in November 1961. Due to budget cuts, the two survivors were retired after the 1962/63 season.

Above: New Zealand's own Antarctic aviation programme developed from modest beginnings with the operation of an Auster T.7C and a Beaver as part of the Commonwealth Trans-Antarctic Expedition of 1956. Subsequently, the aircraft (both unique within the RNZAF) formed the New Zealand Antarctic Flight. The Beaver crashed in a white-out in 1960. The Auster was written off in New Zealand the previous year.

Left: A Neptune thunders across the ice propelled by two piston engines, two jets and a number of jet-assisted take-off bottles. JATO was used by a number of the larger aircraft to help get them off semi-prepared and unprepared strips in Antarctica. On more than one occasion, runaway or non-functioning rockets have led to the loss of an aircraft and JATO is no longer used.

Above: The 1956 Commonwealth Trans-Antarctic Expedition included the only British DHC-3 Otter (XL 710), which was later passed to New Zealand. Today, the civilian British Antarctic Survey operates DHC-6 Twin Otters.

Below: In this view of Williams Field, McMurdo Sound in the 1956/57 season, an R4D, three P2Vs and three UC-1s are visible. The Otter at the rear is the aircraft that broke its back. Williams Field consists of two separate airfields, known as the Ice Runways and the Ski Runways, the former also known as McMurdo. The Ski Runways are only available for use by ski-equipped aircraft and come into their own when the ice begins to thaw in December.

Above and right: Logistic support for Antarctic operations was first supplied by C-54 Skymasters (equipped with JATO) followed by C-124C Globemasters like these and (briefly) C-133 Cargomasters of Military Airlift Command. These aircraft could operate safely from the ice runway in the early part of the summer season, although the third C-124C to arrive on the continent suffered serious damage on landing and another Globemaster carrying a repair crew landed short and was destroyed by fire. Later operations (mainly by the 9th TCS) were safer. The aircraft at right is seen at Christchurch's Harewood airport, sometime during the late 1950s.

Above: Two Lockheed R7V-1/C-121J Constellations were used by VX-6/VXE-6 for transport between Christchurch and McMurdo and for various mapping and sampling projects between 1958 and 1971. **Pegasus** *arrived in 1964 and crashed on the first day of the 1970-71 season, while carrying 80 passengers and crew, none of whom were seriously hurt. The crash occurred on the sixth landing attempt after the weather had closed in at McMurdo beyond the point of no return on a flight from New Zealand.*

Left: The other VX-6 Constellation was R7V-1P 131624, **Phoenix**. *As well as carrying thousands of passengers between New Zealand and Antarctica, this aircraft was fitted with a trap to catch live micro-organisms in the polar skies. Retired in 1971,* **Phoenix** *was sent to Davis-Monthan and later scrapped. A third 'Connie',* **Project Magnet's El Paisano**, *was wrecked at McMurdo during a trans-polar flight in 1960.*

Below: Ten of VXE-6's 17 R4Ds, LC-47s and C-117s were lost in accidents in their 11 Deep Freeze seasons. R4D-5 **Little Horrible** *was retired on the ice in 1961. One aircraft (17274,* **Charlene**) *was converted to a 'wingless taxi' for ground use between Williams Field and McMurdo Base.*

Above: The Hercules appeared in 1960 when the USN was loaned five ski-equipped USAF C-130Ds. By 1961, VX-6 had its own 'Ski-Hercs', designated UV-1L, then C-130BL, then LC-130F from 1962. The LC-130s returned to New Zealand and then the US at the end of each season.

Right: UH-2A Seasprites were used from icebreakers for ice reconnaissance, personnel and light cargo transport. 149021 of HC-5, seen here in the late 1950s, was also seen serving in Antarctica with HC-1 ('UP' tailcodes).

Above: No hangars and extreme weather conditions mean that paint deteriorates rapidly. **R4D-8** *17219* **Semper Shafters USMC** *(left) displays revised and fresher colours than its sister 99853* **Wilshie Duit** *(an ex-DC-3A). Both 'Super Daks' arrived in late 1957, but only 99853 was still going in 1967 when VXE-6 retired the R4D. 17219 was written off after a heavy landing in the Sentinel Mountains in November 1961.*

Above: VX-6 used 17 Dakotas of seven different sub-types, including the R4D-8 as seen here. The systematic exploration of the Antarctic would not have been possible without the ski-equipped Dakota hauling everything from doughnuts to dog teams. The C-47 is immortalised in the names of Antarctic features such as Dakota Pass, R4D Nunatak and Skytrain Ice Rise.

Right and below right: LC-47H 50777 was one of only two serviceable Dakotas in Antarctica on 25 November 1962 when a JATO bottle broke loose and struck a propeller, causing the crash seen here. Thankfully the aircraft landed the right way up and crew injuries were minor. The Dakota, which had been on the ice just over a month, was written off and abandoned on the Davis Glacier.

Above: The RNZAF received its first C-130Hs in 1965. By the end of the year they had joined in the Antarctic programme, and still support each year's operations under the codename Operation Ice Cube. Without skis, they are restricted to McMurdo's ice runway and to supply dropping.

Right: A US Coast Guard HH-52A helicopter takes off from McMurdo en route for Cape Bird. An hour later it had lost power and crashed on the eastern slope of Mt Erebus. The four occupants were rescued uninjured, but the Sea Guard was not recoverable.

Right: Antarctica is not all snow and ice. The Taylor Dry Valley remains snow-free all year round and is the driest part of the driest continent. The HH-52A in the foreground is from the USCG icebreaker Glacier which supported Deep Freeze from the H-19/HUL days.

Below: The first pure jet (as opposed to mixed powerplant) aircraft to land in Antarctica were C-141s of Military Airlift Command in 1966. The bulk of supplies could now be brought in at the beginning of the season before the ice runway thawed, relieving pressure on the LC-130s.

Below right: The isolation of work in the Antarctic breeds a quirky sense of humour. Someone has uprooted a parking meter from Christchurch and transplanted it to the Vanda helipad where a UH-1N risks a ticket. The UH-1N replaced the UH-34 in 1971 and brought twin-engine safety and air transportability to VXE-6 helicopter operations.

Above: The Soviet Union also conducted an Antarctic aviation programme in support of its research efforts on the continent. Relatively little is known about that programme, although doubtless as much drama attended the operation from the ice of An-2s, Li-2s, Il-14s and An-74s (such as this one visiting McMurdo in 1988) as it has done for the Western agencies.

Left: Of the wide variety of aircraft to operate in Antarctica since the first Deep Freeze in 1955, the oddest is this Convair 990 of Modern Air Transport. The four-engined airliner, named Polar Byrd I (N5615), carried people to the ice on charter to the USAF during the 1968/69 season because C-141s were needed in Southeast Asia.

Above: VXE-6 has lost several Hercules in Antarctica, some of them due to wayward JATO bottles. LC-130F 148318, however, fell victim to the particular hazards of polar aviation in 1971 when it taxied over a snowbank in zero visibility while skirting the GCA building at McMurdo. Not visible here is the total destruction of the forward part of the aircraft caused by the resulting fire. At one point in late 1976 all the LC-130Fs were out of action due to mishaps, and all but two of the six LC-130Rs have suffered serious damage at one time or another.

Above: Since 1985, the RNZAF has operated a single UH-1D/H in Antarctica during most seasons. Here USAF and RNZAF crews prepare the 1990/91 aircraft for loading onto a C-141.

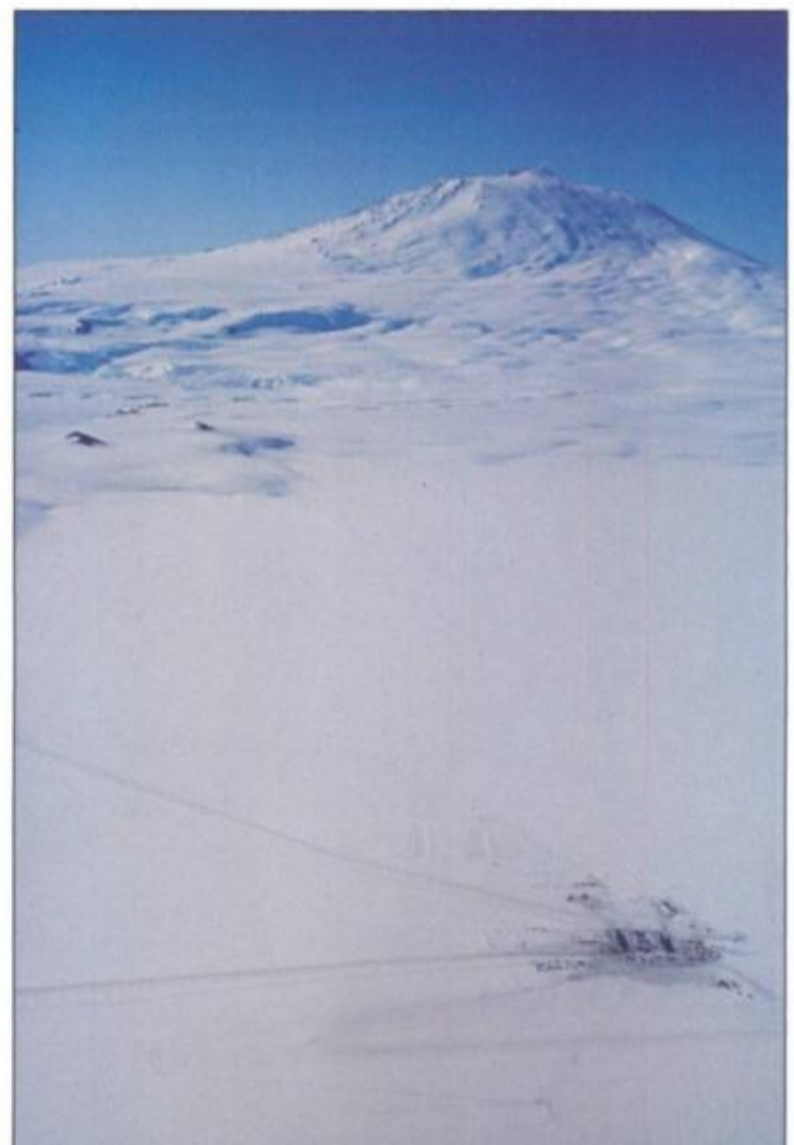
Above: Loading and unloading an Iroquois from a StarLifter is a more complicated business than one might imagine, and is not aided by ice, snow and freezing winds.

Above: The high-visibility Antarctic colour scheme applied to RNZAF UH-1s for several seasons gave rise to the nickname 'Orange Roughy' (a type of Southern Ocean fish).

Above: Maintaining a single helicopter in sub-zero conditions without hangarage puts heavy demands on the small RNZAF detachment. Two aircraft may be used in future seasons. The orange colour scheme was abandoned due to the cost of masking and repainting twice a year.

VXE-6 has also operated some of its UH-1Ns without the traditional vivid red colour scheme associated with Antarctic operations. Against the snow and ice, the contrast of a mostly drab scheme is sufficient, but in the Dry Valley a grey or green helicopter could be lost for a long time.

Right: Mt Erebus (3794 m/12,447 ft) towers above McMurdo Airstrip in this 1967 photo. The two prominent linear features are raised snow roads to Scott Base and the Williams Field Ice Runway. Flights are normally conducted in the Southern Hemisphere summer (November to March), but emergency flights to evacuate injured personnel have been made in mid-winter, guided by burning oildrums in the 24-hour darkness.



Above: The extreme cold, combined with a regular snow covering, acts as an efficient preservative on those aircraft that have been abandoned over the years. Constellation 131644 (Pegasus) has lain at Williams Field since 1970, periodically appearing and disappearing with the shifting snows. A recent initiative to 'clean up the ice' may mean that at least part of Pegasus will leave Antarctica for preservation in a museum.

Above and below: With recent discoveries about the state of the ozone layer, which is thinnest above the poles, Antarctica has become the focus of greatly increased scientific interest. C-141s carry the bulk of the polar specialists and their instruments, while KC-10s refuel the StarLifters involved in the mid-winter supply drop to those wintering over on the ice.

Above: From 1989, the scientific effort in Antarctica was boosted with occasional freight runs by the giant C-5 Galaxy. The Galaxy is so heavy that constant seismological readings are taken while the aircraft is at Williams Field to ensure that the ice runway, which is approximately 2.4 m (8 ft) thick, is not in danger of cracking under the strain.

Right: The Coast Guard finally replaced its 1950s' vintage HH-52s with twin-engined Aérospatiale HH-65 Dolphins in 1985, one of which is seen at Scott Base. All the US services have been represented in Antarctica over the years. As well as the Navy and Air Force, the Army supplied the first C-130s as well as UH-1s, and, more recently, the Air National Guard has become involved.

Below: In addition to the US and New Zealand, C-130s have been operated in Antarctica by Australia, the UK, Italy, Uruguay, Argentina and Chile. Chile, the closest nation to Antarctica, has been at the forefront of tourism and has built a commercial airstrip and a hotel at King George Island, where one of its Hercules is seen.

Above: The enduring image of Antarctic flying has been that of orange-tailed Dakotas and Hercules of the 'Puckered Penguins' operated by the US Navy on behalf of the National Science Foundation. For more than 40 years, VXE-6 has operated in the harshest conditions on earth, including surface temperatures as low as -57°C (-70°F), and has built up an unrivalled base of experience. This is set to change in 1997/98, however, with US budget cuts leading to the contracting out of helicopter services and the replacement of VXE-6's LC-130s by those of the New York ANG.

Right: LC-130F Juliet Delta 321 is the great Antarctic survivor, abandoned at Site D59 in 1971 after JATO bottles knocked out two engines. There it remained, buried by the snow for 17 years, with only a fintip visible. In the meantime, the squadron code reverted to 'XD' and LC-130Rs replaced the Fs. A two-year effort saw JD 321 freed and returned to the US via New Zealand in 1988, with new engines, wiring and control surfaces. The aircraft has not yet rejoined VXE-6.

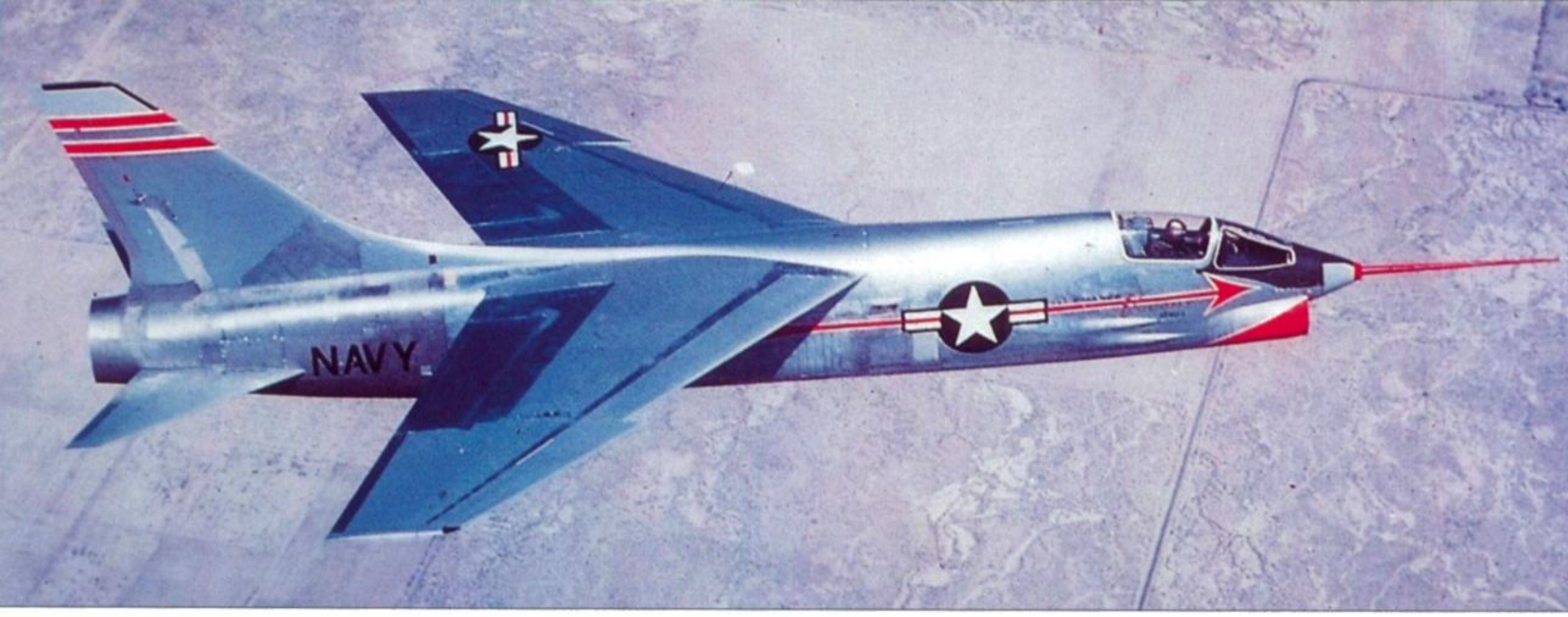
The catapult officer on board USS **Oriskany** *signals for the launch of a VF-111 F-8E during October 1966. The F-8 flew for most of the Vietnam War from the older wooden-decked carriers which could not support the F-4 Phantom. The 'Sundowners' were unique in flying all three major models of the Crusader (F-8C, D and E) in combat.*

Vought F-8 Crusader MiG-Master

Carrier aircraft have traditionally borne the penalty of extra complexity and weight compared to their land-based cousins, with a consequent degradation in performance. Not so with the superb Crusader, which easily outperformed the Air Force jets when it first appeared. It matured into one of the classic jet fighters, renowned as the 'MiG-Master' thanks to its exploits in the Vietnam War. Although long out of US Navy service, it will contine to fly in French hands until the turn of the century, a fitting tribute to the excellence of the original design. Few aircraft types have occupied such a special place in the hearts of their pilots as has the Crusader – the 'Last of the Gunfighters'.

WHEN YOU'RE OUT
OF F-8's

YOU'RE OUT OF
FIGHTERS



From the very beginning the Crusader looked every inch a winner. The clean lines of the early models, demonstrated here by the first XF8U-1 prototype (BuNo. 138899), breathed speed and modernity when the aircraft first flew in 1955.

Right: Vought's Chief Test Pilot, John Konrad, sits in the prototype XF8U-1. Konrad had flown B-17s in World War II, had taken part in the Berlin Airlift and served as a staff pilot for the United Nations in Lebanon. In 1949 he flew as a test pilot at Edwards AFB, before joining Vought in 1953.

By the early 1950s, land-based jet aircraft like the Air Force's 'Century Series' – F-100, F-101, F-102 and F-104 – had made supersonic flight an everyday occurrence. Shipboard aircraft need stronger landing gear, wing-folding mechanisms, and additional radio and survival gear, all of which add hundreds of extra pounds that reduce performance. Thus, naval aircraft never enjoyed better performance than their shore-based counterparts.

The US Navy issued a call for an advanced carrier fighter in September 1952. The Bureau of Aeronautics (BuAer.) request was sent to eight companies: McDonnell, North American, Douglas, Convair, Lockheed, Grumman, Chance Vought and Republic. Only Douglas, Grumman and Vought had any real experience with carrier aircraft; Convair and Republic had absolutely none.

The Navy asked for a fighter capable of Mach 1.2 at 30,000 ft (9144 m), and Mach 0.9 at sea level; a 25,000-ft (7620-m) per minute rate of climb, but only a 100-kt (184-km/h) landing speed. Armament was to include machine-guns or cannon, as well as missiles, coupled with high manoeuvrability. This was in addition to the usual shipboard amenities such as folding wings, ease of handling on the flight deck, and the normal catapult and arresting gear.

While several of the competing companies had one or more successful designs either in testing stages or already in operational use, Vought's dismal post-war record had tarnished its image as a leading supplier of naval aircraft. (Its XF5U, F6U and F7U had not been successful.) This, its fourth fighter design of the late 1940s, had to win.

The experience was there, to be sure. Vought tapped John Russell Clark to lead the design team. 'Russ' Clark had been in the forefront of Vought's earlier attempts, including the F6U and F7U, as had team members Lyman G. Josephs, Bill Schoolfield, Connie Lau, Fred Dickerman and Whit McCormack.

Within five months, the men came up with a number of proposals. The Navy selected Vought Model V-383 as the winner of the competition in May 1953, and ordered several mock-ups and wind-tunnel test models. It also awarded the XF8U-1 designation to the new design. In addition to the V-383 fighter proposal, a photo-reconnaissance platform, V-392, was also of interest, and was later developed into the F8U-1P.

Below right: For many years the XF8U-1 languished in storage at the Smithsonian Institute's Silver Hill depository. This is the aircraft's cockpit, showing all the signs of three decades of neglect.

Below: John Konrad begins the take-off roll of the Crusader's first flight on 25 March 1955. The XF8U-1 had been trucked to Edwards for its maiden voyage, during which Mach 1 was achieved, the first time a Navy fighter had flown supersonically on its first flight.

The Vought team had played several gambles, with a few sure shots. While the XF8U's general layout was fairly straightforward – earlier tailless designs were thrown out – it did include several interesting variations. Perhaps the most unusual area was the wing. Besides being high-mounted, which was something of an anachronism at the time, it was hinged and could be raised 7°. This variable-incidence wing became the F8U's hallmark and, to the end of its days, always caused consternation to younger observers seeing it taxi in, and brought smiles from older veterans.

While perhaps amusing, the movable wing had a deadly serious purpose. Forward visibility, especially during the carrier approach, had never been one of Vought's trademarks. The F4U's long nose had been one of the main reasons for its initial refusal for US carrier operations, and the big F7U's 20° angle of attack (AoA) on take-off and landing made many aviators very uncomfortable.

Carrier approaches are flown by units of AoA, and naval aviators are trained this way from their earliest days. Clark's design team endeavoured to retain the necessary AoA by keeping the wing at the required angle, but allowing the

Left: The first and the last: the XF8U-1 prototype was renovated by VFP-206 personnel and displayed alongside the last operational RF-8G during the unit's close-out ceremonies, held in March 1987 at NAF Washington.

fuselage and the cockpit to be lowered for better pilot visibility. Along with the improved forward view, the aircraft's landing gear could remain at a reasonable weight-saving length without the stalky, and ultimately weaker, assemblies of the F7U, or even Douglas's later A4D Skyhawk.

Additional consideration was also given to the wing's control surfaces. Besides the variable incidence capability, the ailerons and entire leading-edge surfaces were interconnected and automatically lowered to 25°, increasing the camber and thus the lift, while allowing a reduction of approach and take-off speeds. The aerodynamic braking qualities of the raised wing was another bonus.

Wing control

Rear Admiral Tom Irwin describes how the early Crusader pilots operated the unique wing. "There were two controls in the cockpit: one was the positioning handle, and the other a locking handle. After the locking handle was moved to the unlocked or aft position, the positioning handle was moved aft after first depressing a thumb switch on the end. An emergency pneumatic means of activation was available in case of a hydraulic failure.

"The extension of the full-span leading edge was also made to the landing position, as well as lowering the narrow inboard flap segments and ailerons. The speed brake also retracted, if extended, and an automatic re-trim of the Unit Horizontal Tail occurred. This was the normal landing configuration. When the wing was lowered, all surfaces returned to the normal inflight position, with the leading edge going to the position selected for the cruise droop on the throttle handle."

Lowering the wing after take-off was always an interesting experience for new F-8 pilots. Aerodynamically, the fuselage was actually being raised, since the wing was doing the flying. Consequently, the pilot had to 'fly' the fuselage up into the wing while the auto re-trim took place. Procedures called for a higher speed to begin transition than those with which most pilots were comfortable. If too little back pressure was used, the aircraft would settle; too much, and it would climb or porpoise. The correct way was a perfectly level and steady transition to the end of the runway.

An early Crusader leads a pair of F7U-3 Cutlasses, illustrating the advances made by the Vought company in fighter design in one generation. The F7U was a disappointing aircraft which suffered from a very high angle of attack on approach, a problem rectified in the F8U by the novel variable-incidence wing.

Formation transitions were always interesting, especially in instrument conditions. Standardised signals were used to alert the wingman and to indicate execution. If the wingman failed to anticipate a configuration change, or missed the execute signal, vertical separation and a red face resulted.

Landing with the wing down was possible ashore but very risky aboard the ship, although it was done successfully on several occasions. The approach speed had to be increased by about 30 kt (55 km/h), even if the landing droop was available, to avoid touching down tailpipe first.

Special attention was also given to the new fighter's construction, using lightweight metals like titanium and the Vought-developed Metallite.

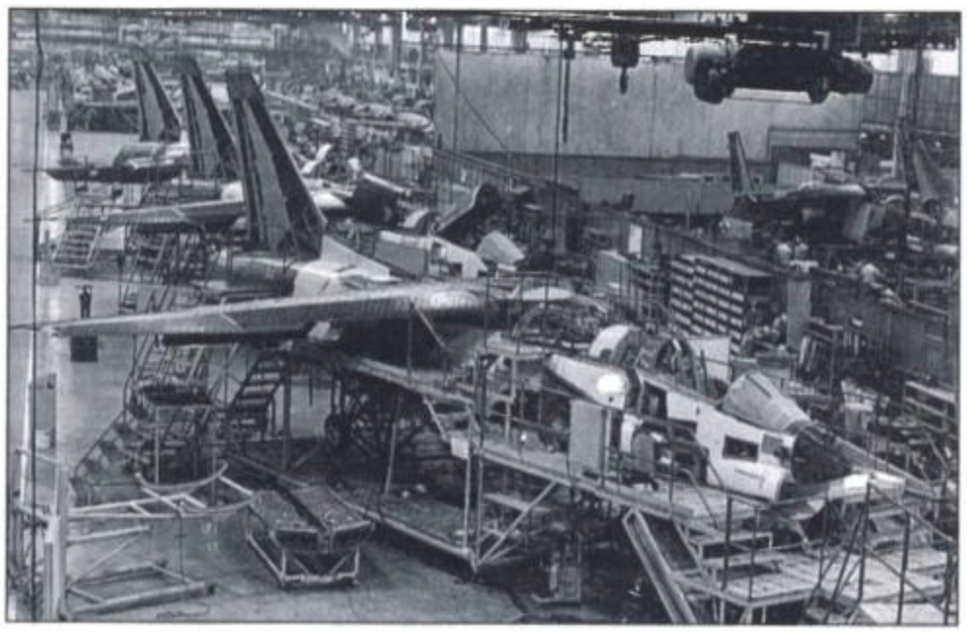
Newly applied aerodynamics were included, mainly the recently developed area-ruled fuselage, the so-called 'Coke bottle'. This design 'pinched' the waist of the aircraft's fuse-

Another view of the first prototype displays the different shades of metal. Noticeable is the position of the arrester hook and ventral airbrake.

Prototypes

Vought built two prototypes for the Crusader, both equipped with an air data sensor probe. The design needed no major fixes, and production aircraft began leaving the factory soon after the type's first flight.

Below: This is the second XF8U-1 prototype (BuNo. 138900), seen at Carswell AFB, near Fort Worth. Vought used this base for testing as the runways at Dallas were too short.



Above: This is the F8U-1 production line at Dallas, with aircraft angled in to conserve space. On a trolley in front of this aircraft is a ventral rocket pack awaiting fitment.

Above right: Inflight-refuelling capability was installed from the outset. Here an early production F8U-1 demonstrates receiving from a North American AJ-2 Savage. Note the tail-down attitude needed to stay with the much slower tanker.

lage, producing a reduction in drag, thereby increasing speeds eventually attained by the XF8U and all other jet fighters to follow. A unique feature was the ram air turbine, colloquially known as 'the RAT' by every F-8 pilot to come. Installed on a hinged panel in the right side of the forward fuselage, the RAT provided emergency hydraulic and electrical power. During the F-8's long career, the RAT saved many aircraft.

Armament consisted of four 20-mm Colt Mk 12 cannons, two on each side of the forward fuselage, with 144 rounds per gun. There was also provision for 'cheek' rails immediately aft of the cockpit, to carry one Sidewinder air-to-air missile each. Later development enabled an additional Sidewinder per rail to be carried, giving a total of four. However, in combat in Vietnam, four missiles were seldom carried because of weight and fuel considerations. Early tests of the Sidewinder, the first practical air-to-air missile, began in September 1953 with firings from a Grumman F9F-8 Cougar. The Sidewinder destroyed a Hellcat drone.

The XF8U also included a huge internal supply of fuel, more than 1,300 US gal (4921 litres) in wing and fuselage tanks. With a maximum endurance of three hours, the F-8 series seldom, if ever, carried additional external fuel tanks. The RF-8 reconnaissance aircraft's range enabled it to fly far-ranging missions in Southeast Asia, and, barring any extended heavy manoeuvring to evade enemy defences, the RF-8 would return to its carrier with a comfortable amount of reserve fuel. Inflight-refuelling capability, a Navy requirement beginning in September 1955, was later included in production models; the retractable probe was enclosed beneath a blister on the left side, aft of the cockpit.

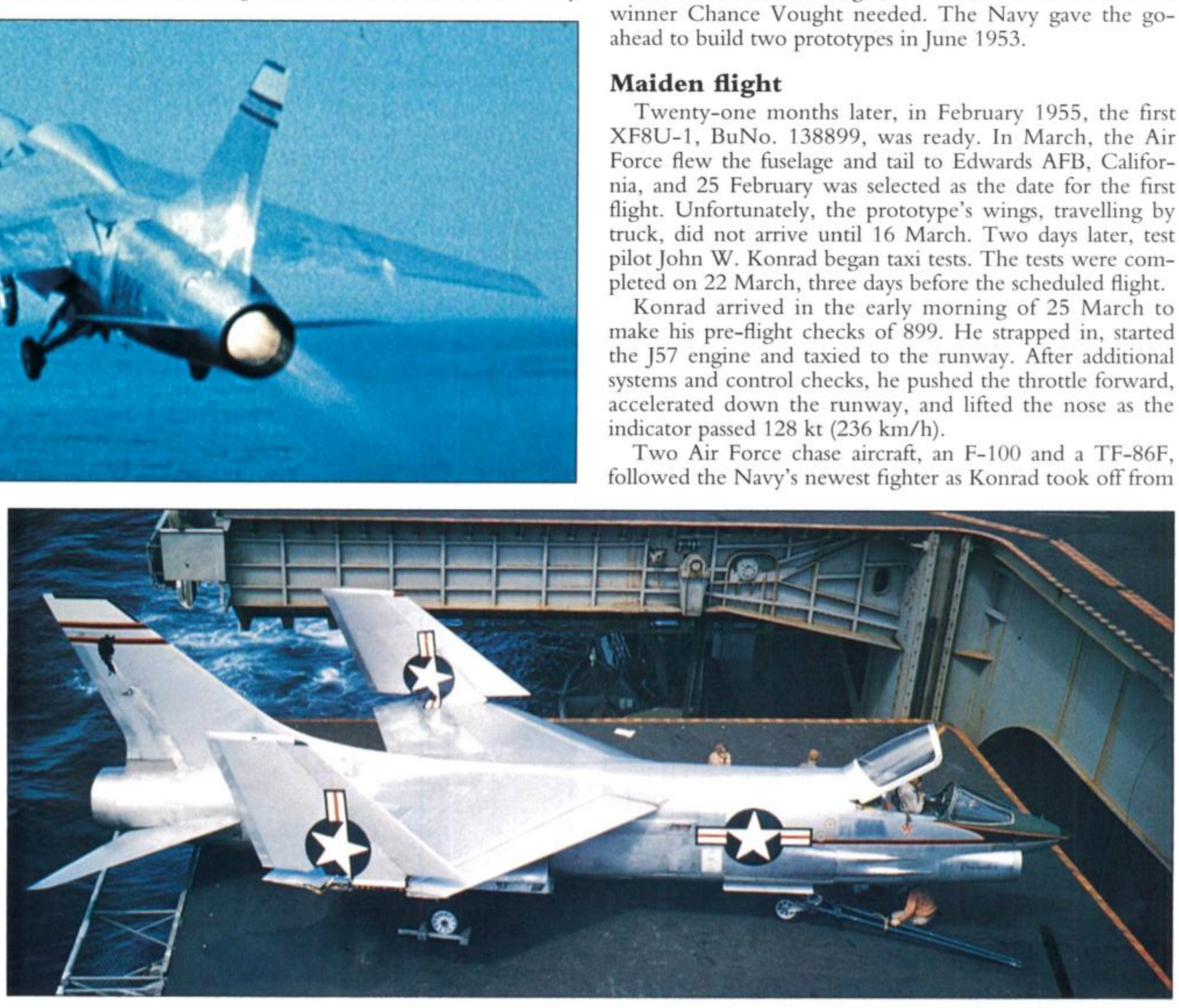
With all these advantages, the XF8U-1 looked like the winner Chance Vought needed. The Navy gave the go-ahead to build two prototypes in June 1953.

Maiden flight

Twenty-one months later, in February 1955, the first XF8U-1, BuNo. 138899, was ready. In March, the Air Force flew the fuselage and tail to Edwards AFB, California, and 25 February was selected as the date for the first flight. Unfortunately, the prototype's wings, travelling by truck, did not arrive until 16 March. Two days later, test pilot John W. Konrad began taxi tests. The tests were completed on 22 March, three days before the scheduled flight.

Konrad arrived in the early morning of 25 March to make his pre-flight checks of 899. He strapped in, started the J57 engine and taxied to the runway. After additional systems and control checks, he pushed the throttle forward, accelerated down the runway, and lifted the nose as the indicator passed 128 kt (236 km/h).

Two Air Force chase aircraft, an F-100 and a TF-86F, followed the Navy's newest fighter as Konrad took off from



Above and right: The first production F8U-1s were handed over to the Navy in September 1955 to allow pilot training to begin. Carrier trials started in April 1956, using this aircraft, BuNo. 140446, the third production aircraft. Commander 'Duke' Windsor from Patuxent River flew the initial batch of trials, USS Forrestal sailing from Norfolk for the tests. In addition to a series of launches, bolters and recoveries, deck-handling trials was undertaken.

the dry lake bed. After preliminary flight checks, Konrad punched in the afterburner, and climbed. As he reached 35,000 ft (10668 m) he accelerated past Mach 1.0, the first time a Navy fighter had gone faster than sound in level flight. After 52 minutes Konrad brought the XF8U back, greatly impressed with the new aircraft. By the time the second prototype, BuNo. 138900, made its first flight on 12 June, again with John Konrad at the controls, it had been officially dubbed the Crusader.

The XF8U-1, number 899, made 508 flights during its five years of testing, passing the 100th flight only six months after the first one. It used 17 different Pratt & Whitney J57 engines in the process. Eventually, 'the One X', as it came to be called, was donated to the Smithsonian Institution in Washington, DC. Test pilot Bob Rostine flew 899 from Dallas to NAS Patuxent River, Maryland in early October 1960. From there, John Konrad flew it to Washington's National Airport on 25 October, where, after shutting down the aircraft, he presented its logbooks to Vought and Navy officials. Vice CNO Admiral J. S. Russell then presented the aircraft to Dr Remington Kellogg, acting Secretary for the Smithsonian.

Unfortunately, 'the One X' languished at the Smithsonian's Silver Hill storage facility in suburban Maryland, gathering 27 years of dust and greasy soot in the corner of a darkened Quonset hut, nearly forgotten, until the end of the Crusader's career approached. The second XF8U-1, 900, was scrapped after 460 flights.

Initial fleet introduction and record runs

The first production F8U-1, BuNo. 140444, left the Dallas plant on 20 September 1955. The Marine Corps accepted its first production F8U in January 1956, by which time three Crusaders a month were being produced.

Ship-to-ship dash

As part of the ongoing competition for funding, the US Navy staged an impressive coast-to-coast flight from Bon Homme Richard, sailing off California, to Saratoga in the waters off Florida, covering the distance in just under 3½ hours, including one inflight refuelling from Savage tankers. President Eisenhower was aboard 'Sara' to welcome the two VX-3 pilots on their return.

Far left: The two VX-3 F8U-1s line up on Bon Homme Richard's *catapults prior to the ship-to-ship dash.*

Left: President Dwight Eisenhower welcomes Captain Robert Dose (third from left) and Lieutenant Commande Paul Miller (second from right) on board Saratoga *on 6 June 1957. The official flight time from the Pacific carrier was 3 hours 28 minutes.*

The first fleet pilots had also begun training at NAS Patuxent River. The first 13 Crusader pilots came from VF-32 at Cecil Field, Florida, and VF(AW)-3, an all-weather fighter squadron based at NAS Moffett Field, California.

Initial carrier qualifications for the F8U were scheduled for April 1956. Commander 'Duke' Windsor, a Patuxent River test pilot, conducted practice landings there in late March with the third pre-production F8U, BuNo. 140446. The aircraft was then loaded on board the carrier USS *Forrestal* (CVA-59) at Norfolk, Virginia.

On 4 April, as 'Russ' Clark and a group of company executives watched, Windsor made six touch-and-goes on the *Forrestal*. Then, he and the new fighter made the Crusader's first catapult launch. During the next two days, Windsor made 12 landings and launches. The fifth catapult shot nearly resulted in the destruction of the aircraft when, during the cat stroke, the Crusader suddenly skidded down the deck at an awkward angle.

Reacting immediately, Windsor retarded the throttle to idle and stood on the brakes. The aircraft stopped only 4 ft (1.2 m) from the carrier's bow. Since no damage was done, the launches continued. A second qualification period on 18 April saw 11 more landings and 12 launches.

As the development and introduction of the F8U proceeded, the Crusader captured a number of performance

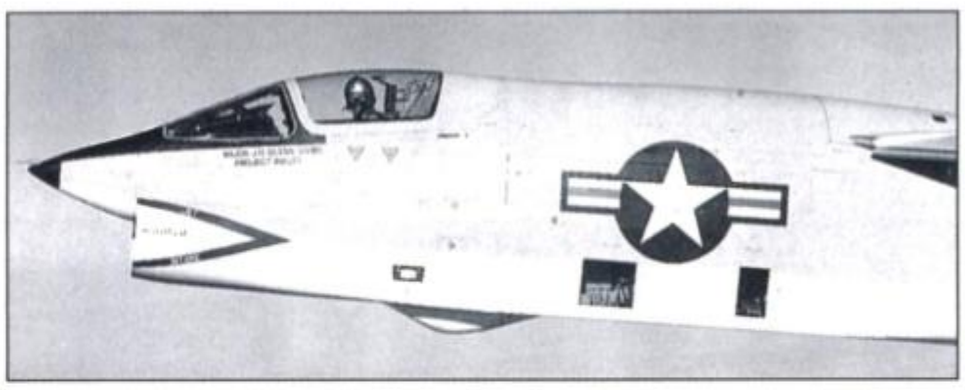
This close-up of Glenn's F8U-1P during the Project Bullet run shows clearly the two camera windows and camera fairing. VFP-61 loaded the cameras for the Bullet flight, which provided a coast-to-coast strip of photography.

Project Bullet

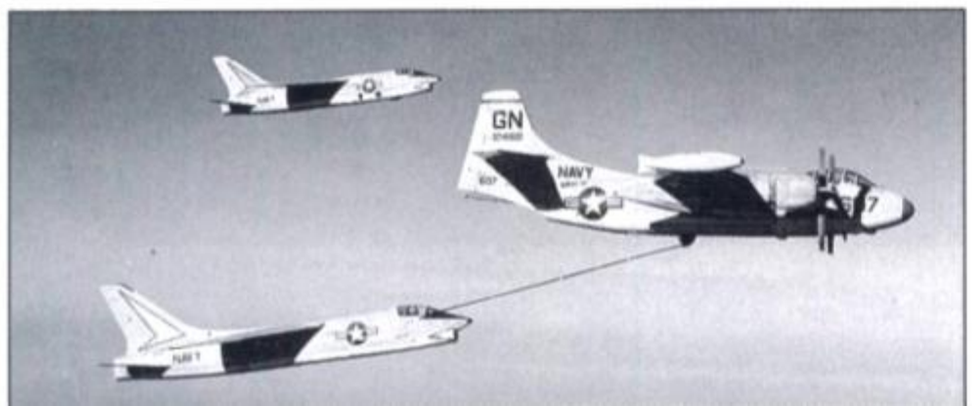
The best-known of the Crusader's record runs was the coast-to-coast flight on 16 July 1957, using an F8U-1P (BuNo. 144608) flown by Major John Glenn and an F8U-1 flown by Lieutenant Commander Charles Demmler. Taking off from Los Angeles, the pair flew supersonically to the first refuelling, where Demmler's probe was damaged, forcing him to retire. Glenn carried on, landing at New York 3 hours and 23 minutes after take-off, having photographed the entire strip of land beneath his aircraft during the run.

Below: A rare shot shows Demmler and Glenn at the first refuelling with a VAH-11 AJ-2. During this rendezvous Demmler's refuelling system was damaged.

Above: Major John Glenn poses in the cockpit of his F8U-1P. He was later to achieve fame as the first American to orbit the earth and as a Senator representing the state of Ohio.



Below: Glenn's aircraft was the third F8U-1P, this photo-version having a swollen forward fuselage to accommodate cameras.



Above: VX-3 was the first US Navy Crusader squadron, receiving its F8U-1s in December 1956. It became the main service evaluation unit. Here five of its 'XC'-coded aircraft are seen parked on Roosevelt for carrier trials, including testing of the mirror landing system.

Right: VF(AW)-3 was an early recipient of the F8U-1, the Crusaders replacing F4D Skyrays. Based at NAS Moffett Field, the 'Blue Nemesis' unit was tasked with NORAD duties as well as operating as a tactical training unit. Moffett's landmark blimp sheds can clearly be seen.

records and several prestigious aeronautical trophies. To show off its new fighter, the Navy determined to surpass Air Force speed records. 'Duke' Windsor was tasked to push the Crusader past the magic 1,000-mph (1609-km/h) mark. Named Project One Grand, the attempt would be made in California's Mojave Desert. With the most F8U time of any Navy test pilot, and already having taken a Crusader unofficially up to 1,100 mph (1770 km/h), Windsor anticipated no problems.

The Air Force threw the Navy a curve, however, when one of its new F-100C Super Sabres achieved 822 mph (1323 km/h), Mach 1.25, on 20 August 1955. Undaunted, the Navy scheduled its attempt for one year later, by which time the British held the level speed record with the Fairey Delta 2, an experimental aircraft that had flown at 1,132 mph (1822 km/h).

Actually, the Navy did not want Windsor to take the F8U to its top speed because it did not want to disclose the full capabilities of the new aircraft. Windsor was told to simply top the 1,000-mph mark. Early on the morning of 21 August 1956, he took off from MCAS Mojave, in F8U-1 BuNo. 141345, the 12th production fighter, climbed to 40,000 ft (12192 m) and, in two speed runs, hit an average speed of 1,015 mph (1633 km/h), a little slower than the British mark but nearly 200 mph (322 km/h) faster than the Air Force's record.

This achievement won the Thompson Trophy for the Navy and Vought. CNO Admiral Arleigh A. Burke, with Commander Windsor, received the trophy at ceremonies in Oklahoma City in early September. It was just the beginning of the Crusader's year of records.

VX-3's ship-to-ship dash

A visit to the new 'Forrestal'-class carrier *Saratoga* (CVA-60) by President Dwight Eisenhower afforded the Navy its next opportunity to parade the Crusader. Captain Robert G. Dose, commanding officer of VX-3 based at Atlantic City, New Jersey, led his squadron operations officer, Lieutenant Commander Paul Miller, on a cross-country dash. Launching on 6 June 1957 from USS *Bon Homme Richard* (CVA-31) off the California coast, Dose and Miller flew toward Dallas. Above the F8U's home, the two F8U-1s refuelled from two waiting AJ-2 tankers. Disengaging from the tankers, the Crusaders blasted back up to their cruising altitude of 45,000 ft (13716 m) and their cruise speed of Mach 0.96.

Finally, as they approached the East Coast, the two pilots descended towards the *Saratoga*, 50 miles (80 km) off Jacksonville. As VX-3's landing signal officer, Lieutenant Commander Ken Sharp, monitored their approach to the big ship, Dose and Miller made a fast flyby at 600 kt (1106 km/h), barely 75 ft (23 m) above the water. Skidding around in tight turns, the two Crusaders then lined up, desperately trying to slow down to approach speed, and eventually trapped – made an arrested landing – in front of their admiring commander-in-chief. It was an impressive display, and the elapsed time from launch to trap was three hours and 28 minutes, an unofficial record.

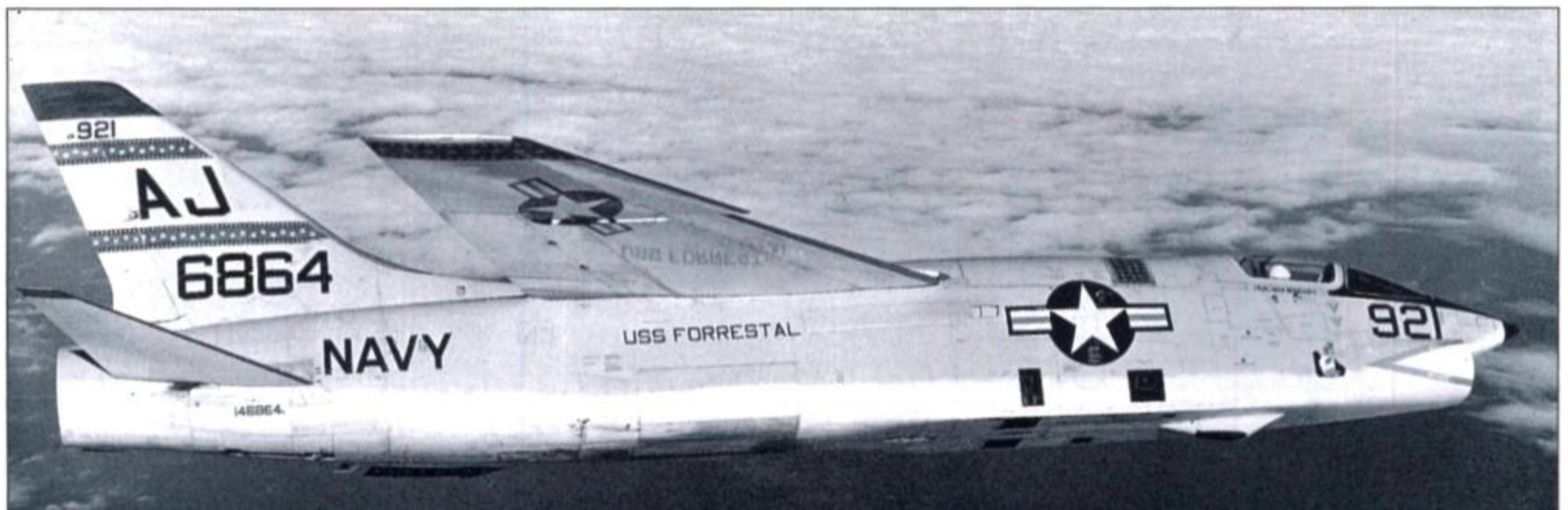
John Glenn's Project Bullet

Another transcontinental dash took place the following July, this time involving the photo-reconnaissance variant F8U-1P. Then-Marine Major John H. Glenn, with the sponsorship of the Navy's Air Test Center at Patuxent River, planned a west-to-east transcontinental dash known as Project Bullet. The flight would be made at supersonic speed and in the course of it the entire US would be photographed. Glenn would fly the third -1P, BuNo. 144608, escorted by Navy Lieutenant Commander Charles Demmler in an F8U-1 fighter and supported by Navy squadrons VAH-6 and VAH-11 providing AJ-1 Savages as inflight tankers and equipment support. VFP-61 prepared the cameras in Glenn's aircraft. The two Crusaders took off from Los Angeles at 06.00 on 16 July.

Demmler was forced to abort the flight when his aircraft's inflight-refuelling probe was damaged during the first refuelling. Glenn pressed on alone and three hours and 23 minutes later touched down at New York's Floyd Bennett

Above: VF-32 was the first operational squadron to get F8U-1s (illustrated), equipping in March 1957. It soon received F8U-2s.

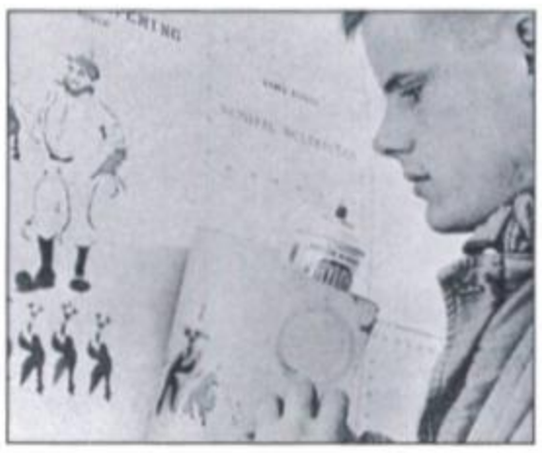
Right: The F8U-1P entered service in September 1957 with VFP-61. VFP-62 (illustrated) was the second unit, this example being seen in March 1960.



RF-8 over Cuba

During the Cuban Missile Crisis of 1962, RF-8As of both the Navy's VFP-62 and the Marine Corps' VMCJ-2 were tasked with providing low-level photography of the island under the Blue Moon codename. For six weeks the Crusaders flew over Cuba, flying up to 14 sorties per day.

Above: Still in flight gear, Commander William Ecker studies the results of his mission with PIs after returning to Jacksonville.



Above: A dead chicken was used as a mission mark for each flight over Cuba. The RF-8s partnered Air Force RF-101s in monitoring the island.

Commander William Ecker parks his RF-8A after a mission over Cuba in late 1962. On the nose of the aircraft is the coveted Navy Unit Commendation, awarded on 26 November 1962. It was the first occasion the award had been made in peacetime.

Field. The average speed was 725.55 mph (1167.63 km/h), Mach 1.1. Glenn's Crusader was eventually remanufactured as an RF-8G. In December 1972 it struck the flight deck of the carrier *Oriskany* (CV-34), and its young pilot ejected. John Glenn's Project Bullet aircraft rests at the bottom of the South China Sea off Vietnam. The F8U's impressive performances earned Vought and the Navy the Collier Trophy, which cited the "concept, design, and development of the first carrier-based fighter capable of speeds exceeding 1,000 mph."

While the early Crusaders garnered public recognition, the F8U-1 was entering the fleet. VX-3 received the initial production F8U-1s in December 1956, but VF-32 was the first fleet squadron to re-equip at NAS Cecil Field in March 1957, followed by West Coast squadrons VF-154 and VF(AW)-3. Then came VF-211, VF 142 and VF-143. The first US Marine Corps squadrons took their Crusaders in December 1957 – VMF-122, followed by VMFs 312, 333, and 334. February 1958 saw the first Crusader deployment, in USS *Hancock* (CVA-19) with VF-194 in the Pacific, and VF-32 in *Saratoga* for the first Atlantic deployment.

Lebanon, 1958

Events in the Lebanon brought direct US intervention in the summer of 1958 when President Eisenhower ordered an amphibious landing by the Marines. While largely unopposed, the Marine amphibious landing in July 1958 was the only such large-scale operation in a peacetime setting. The US was not really prepared to support a major landing. Much of the required air power was stationed in the US; the nearest carrier task force, with the new *Saratoga*, was 1,700 miles (2734 km) away at Cannes, France.

Nonetheless, just after 15.00 on 15 July, and preceded by a flyover of more than 50 aircraft from the carrier *Essex* (CVS-9), the Marines landed 4 miles (6.5 km) south of Beirut, and 0.5 mile (0.8 km) from Beirut International Airport. A second landing followed the next morning. VF-32 flew its new F8U-2s from *Saratoga* during the crisis, patrolling the eastern Mediterranean beaches during the landings. It was the first time the Crusader had entered a hostile area. *Forrestal*, with VMF-333 and its F8U-2s, relieved its sister carrier in September in the eastern Mediterranean.

The photo-reconnaissance platform

As the fighter enjoyed a highly successful introduction, development of a dedicated photo-reconnaissance platform also began, using the 32nd F8U-1, BuNo. 141363. The fighter's four 20-mm cannon and related fire controls were deleted. To accommodate the cameras and film canisters, the fuselage's belly was flattened and the inflight-refuelling probe was completely enclosed, thereby changing the characteristic 'bump' on the Crusader's port side. The horizontal tail was reduced to increase the aircraft's speed, which would be its only defence.

The original suite of cameras included three trimetrogen cameras, which provided horizon-to-horizon coverage at Station 2, actually the aft-most bay. Eventually, the definitive camera arrangement was as follows: two cameras giving vertical and oblique views in Stations 3 and 4, while Station 1, located below and forward of the cockpit, mounted a forward-looking oblique camera that photographed the aircraft's flight path. Station 1 could also operate a 16-mm movie camera.

Although the cameras in Stations 3 and 4 could give several degrees of obliquity, those most commonly used were 5°, 15° and 30°. The cameras were manufactured by Chicago Aerial and were designated KA-66 (Station 2), KA-51, 53

Below left: F8U-1s of VF-103 'Sluggers' return to the USS Forrestal *in October 1959. The carrier was on duty in the eastern Mediterranean at the time, maintaining the watch on the troubled nation of Lebanon.*

Below: VF-142 was another of the early Crusader squadrons, receiving its F8U-1s in 1957. Here a pair of 'Fighting Falcons' Crusaders is seen over the home base of NAS Miramar.

Above: The 'Hunters' of VF-162 became one of the best-known Crusader squadrons, although they did not receive their first aircraft until 1962. During that year the F8U-1 was redesignated F-8A as part of the tri-service rationalisation.

Right: The first Marine unit to receive Crusaders was Beaufort-based VMF-122. Its F8U-1s began arriving in December 1957.

Far right: As more advanced variants entered service, many of the F8U-1s were relegated to second-line units flying support duties such as target-towing. One such squadron was VC-10, based at Guantanamo Bay, the US Navy outpost on Cuba. This aircraft is seen in March 1962, before the Missile Crisis made this area one of the most dangerous in the world.

or 62 (Stations 3 and 4) and KA-45 or 51 (Station 1). Lens focal lengths varied from 3 in (7.62 cm) in the KA-66 pan camera to 6 and 12 in (15.2 and 30.4 cm) in the oblique and vertical cameras. The vertical cameras in Stations 3 and 4 were also used for air-to-air photography, beloved of squadron public affairs officers and enthusiasts. Nothing matched a well-lit 5 x 5-in (12.7 x 12.7-cm) aerial negative and resulting prints taken by an experienced F8U-1P pilot.

Aerial photography with the F8U-1P became a fine art, and skill could only be acquired with experience. During photo sessions, the Crusader pilot had to direct the aircraft he was photographing to get the proper line-up in formation shots and the best lighting. It took skill and, at times, command directness, to obtain the right shot. Normally, all the photo pilot had to help him compose his view was a moveable reticle, a brass ring mounted on a pantograph arm on the sides of his canopy.

Besides the air-to-air, and vertical and oblique air-to-ground photography, the F8U-1P carried one other oblique camera in a bay directly beneath the nose (Station 1), looking forward along the flight path. This so-called 'forward fire' provided ingress routes to targets for bombers, and its coverage was extremely valuable during the Vietnam War. The 16-mm movie camera previously mentioned was rarely used.

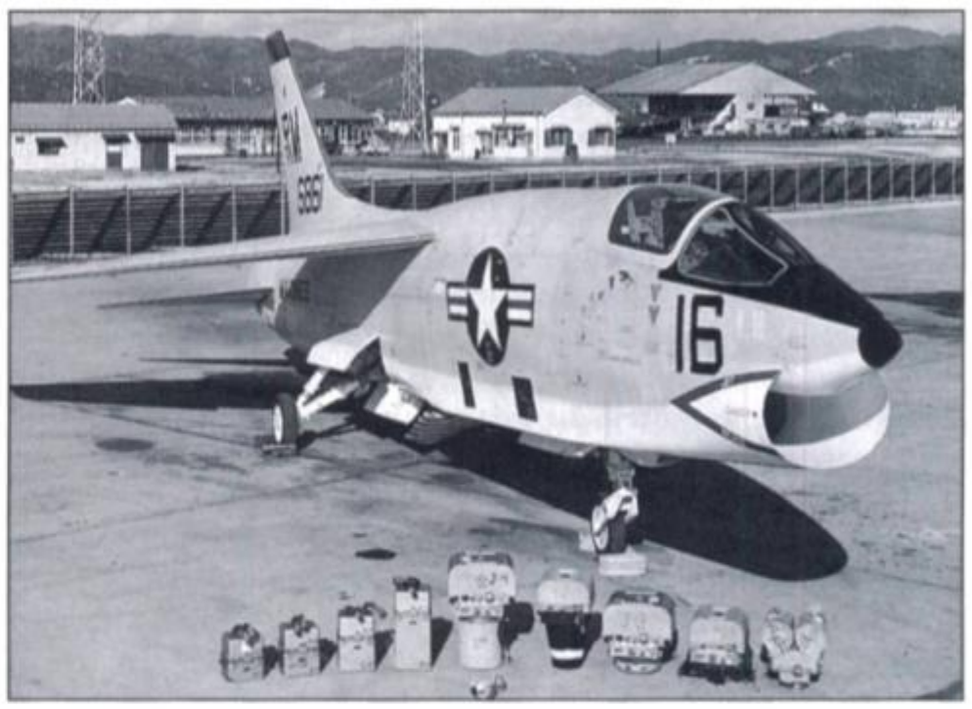
The mid-fuselage Station 2's panoramic camera, or simply 'pan', originally housed the KA-66 which gave a 70-mm (3-in) wide strip, which was useful only for locating the aircraft's position and certain landmarks. However, the later change to the KA-68 with a larger 5-in (12.7-cm) strip allowed the 'pan' camera to become a more useful sensor.

The F8U-1P flew on 17 December 1956, and during the brief two-year period of production the photo Crusaders went through several internal refinements and minor modifications, including strengthening of the wings and changes to the electronic avionics. The RF-8G incorporated ventral rear-fuselage strakes for increased high-altitude stability and joined the fleet in October 1965.

In September 1962, the designation system for all US military aircraft changed to reflect a more unified, simpler format. According to one story, the change came about due to Secretary of Defense Robert McNamara's embarrassment at not understanding the existing system. Thus, the F8U was redesignated F-8, and the F8U-1P photo variant became the RF-8A. From this point in this narrative, the Crusader series will be referred to in the post-1962 system.

The RF-8A joins the fleet

The first Navy squadron to deploy with RF-8As was VFP-61, which began life right after World War II as one of two fleet reconnaissance units. This squadron served throughout the Korean War as VC-61, flying a variety of jets such as the F9F-2P Panther and earlier prop-driven photo-fighters like the F4U-5P Corsair. Redesignated VFP in July 1956, it received its first Crusaders in September 1957. VFP-61's Detachment Alpha in the USS *Midway*



An RF-8A from VFP-63's **Constellation** *detachment refuels from a buddy-pod equipped A-4C of VA-146. The Crusader was undertaking a combat mission into Laos in August 1963. During this period the RF-8s maintained a close watch on Communist movements. Less than a year later the first RF-8A, also from 'Connie', was lost to enemy action over Laos.*

F8U-1P

The photo-reconnaissance Crusader had a redesigned forward fuselage with a flat bottom and bulged sides to house cameras.

The tailplane was reduced in size to increase speed at the expense of agility. No radar was fitted. The first example was produced by conversion of an F8U-1.

Above: Photographed in 1959, this VMCJ-1 F8U-1P is shown with the various camera options. The aft bay initially featured a trimetrogon three-camera arrangement.

Below: An F8U-1P of the third Marine reconnaissance unit, VMCJ-3, is readied for launch from USS **Lexington** *in August 1961. The deck crew are preparing to attach the catapult bridle.*

(CVA-41) deployed with its new aircraft later that year.

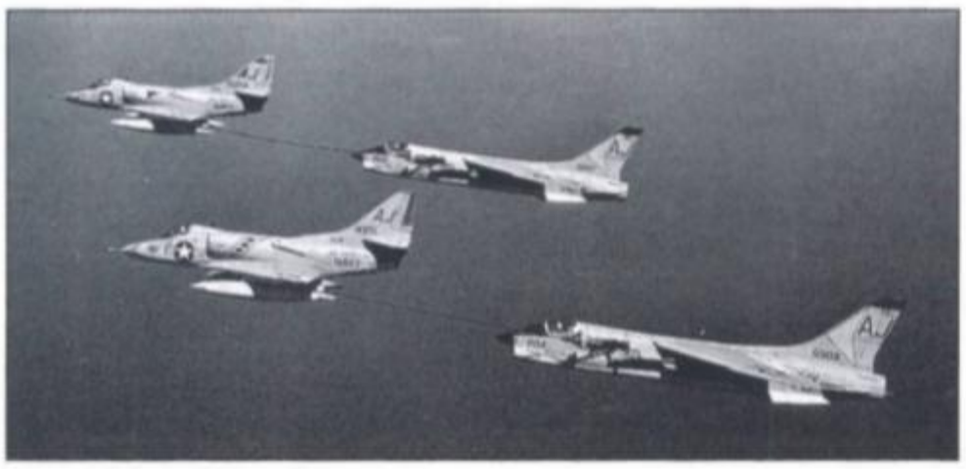
Along the way, VFP-61 and VFP-62 acquired the big A3D Skywarrior and were redesignated VAP-61 and VAP-62. Light photographic duties were assumed by VCP-62 and 63, which exchanged their A3Ds for RF-8As.

The photo Crusader's first operational test came in the late autumn of 1962 and involved both Navy and Marine RF-8As. USAF U-2 reconnaissance flights had brought back indications, but not incontestable proof, that the Soviets had introduced intermediate-range ballistic missiles (IRBMs) into their client state, the Communist-inclined island of Cuba. On 13 October, in conjunction with continued USAF flights, VFP-62 and Marine squadron VMCJ-2 were detailed to stand by at NAS Cecil Field. The RF-8As were needed for low-level, high-speed reconnaissance to confirm the earlier U-2 photos, which only showed earth moving and unconfirmed construction activity. Cuban agents gave information about possible missile bases, and the US government wanted a closer look.

Greater coverage

A high-flying U-2 might take only one or two frames per minute, but an RF-8 travelling at 600 kt (1106 km/h) at 5,000 ft (1524 m) could take several frames per second. The coverage was thus much greater and more detailed. While VFP-62 scrambled to get detachments to carriers, in case the big ships went on a war footing, the land-based 'home squadron' prepared for operations over Cuba.

Four Marine pilots were assigned to VFP-62 to provide additional resources and fly the Navy squadron's RF-8s.



Far left: The F8U-1E (F-8B) first flew in September 1958, introducing airborne interception radar in the form of the AN/APS-67. This gave limited all-weather capability. The B could be easily identified by its black radome and lack of ventral fins.

Left: Despite the 'F8U-1' titles, this aircraft was the XF8U-2 trials aircraft for the F8U-2 (F-8C) series. The key features of the 'Charlie' were the new engine (with distinctive afterburner cooling intakes) and the ventral fins.

The flights began on 23 October 1962, under the codename Blue Moon. Six aircraft flew against three targets, two RF-8s apiece; two aircraft always flew each mission. Fourteen flights were made on 27 October, the greatest number during the entire operation.

The RF-8As made two flights daily from NAS Key West with low-level, high-speed dashes over the heavily-defended island, then landed at NAS Jacksonville where the Crusaders' film was downloaded and rushed for processing and interpretation to the Fleet Air Photo Lab (FAPL) owned by VFP-62. After downloading the film, the Crusaders then returned to Cecil Field, a short distance from Jacksonville, for maintenance. Then they returned to Key West for the next missions. In a six-week period, the RF-8s brought back more than 160,000 negatives.

The Missile Crisis was in full swing as the US instituted a naval blockade, challenging the Soviets' continued movement to and from Cuba. Never has the world seemed so close to nuclear war. Finally, after a week of diplomatic furore, the Russians agreed to dismantle the missile installa-

The F-8C was the first really effective model of the Crusader, the extra power of the Dash 16 engine giving the type sparkling performance, while the capability to mount four AIM-9 Sidewinders significantly increased combat persistence on short-range missions. The F-8C was operated by VMF-323 'Death Rattlers' between the F8U-1 and F-8E.

Above left: F-8Cs of VF-103 refuel from VA-81 A-4Cs, all four aircraft being part of Forrestal's *air wing. Although able to carry four Sidewinders, two remained the normal loadout.*

Left: VF-111 was unusual in beginning its career on F8U-2Ns (F-8Ds) and then reverting to the F-8C. This 'Charlie', seen at Miramar, was assigned to USS Intrepid, *and carries the name 'Tiger' on the fin stripe.*

F8U-2N

The F8U-2N (later F-8D) was in many ways the ultimate fighter model of the Crusader. It was powered by the uprated J57-P-20 which gave a considerable increase in power over the P-16 of the F-8C, while it did not feature the air-to-ground equipment of the F-8E. Most pilots considered the F-8D to be the fastest of the breed, and also the most enjoyable to fly. Most were fitted with an IRST sensor just forward of the cockpit to augment the radar on airborne interceptions.

This was the first prototype for the F8U-2N, the aircraft having flown in February 1960. It was further modified to test F8U-2NE equipment, receiving the avionics hump for the Bullpup missile.

Above: This aircraft was the second F8U-2N, shown in full fighter fit with four AIM-9B Sidewinder missiles.

Below: This view of the first F8U-2N (BuNo. 147035) shows it undertaking air-to-ground trials for the F8U-2NE.

tions and remove them from Cuba.

While the delicate negotiations continued, so did the Blue Moon flights. After landing at Jacksonville after each mission, each Crusader received another 'dead chicken' marking below its cockpit to denote another mission. (The marking referred to a comical situation involving Cuban Premier Fidel Castro who, on an early visit to New York City in 1960, had demanded that a live chicken be killed and cooked for him on the spot to prevent someone trying to assassinate him by poisoning his food.) In addition to the 'chicken' markings, every Crusader had "Smile, you're on Candid Camera" painted on the lower fuselage surface immediately in front of the Station 1 camera blister. The 12 regular squadron Navy pilots and four Marines received Distinguished Flying Crosses, while VFP-62 received the first peacetime Navy Unit Commendation, personally presented by President John F. Kennedy on 26 November 1962.

Flying the Crusader and initial problems

While the F-8 was enjoying a highly successful service introduction, several new Crusader pilots experienced varying degrees of problems handling the new fighter, especially during the close-in phase of the carrier approach. The problem was especially notable during operations around the smaller 'Essex'-class carriers. Known as '27-Charlies', these 27,000-ton ships had much smaller decks than the 'Forrestal'-class ships then joining the fleet, and featured several modifications including angled decks.

The Crusader's high approach speed of 147 kt (271 km/h) made judging the approach difficult for neophytes. A lapse of attention could end up in a ramp strike where the aircraft hit the round-down, the extreme aft portion of the carrier's flight deck. The aircraft could then either break up and slide across the deck, or explode in a blinding ball of flame. Either way, the pilot was extremely lucky to get out alive.

Consistent airspeed was the key to a good approach and eventually a device called the Approach Power Compensator appeared, although not until August 1964. The device had been in testing stages as early as 1960, with production approved in 1962. Called either the APC or the auto-throttle, this system consisted of a computer, accelerometer, a servo-amplifier and actuator, and the pilot's control panel, all interfaced with the existing AOA detector. The APC panel was on the left console immediately beside the pilot's left leg and consisted of a row of toggle switches.

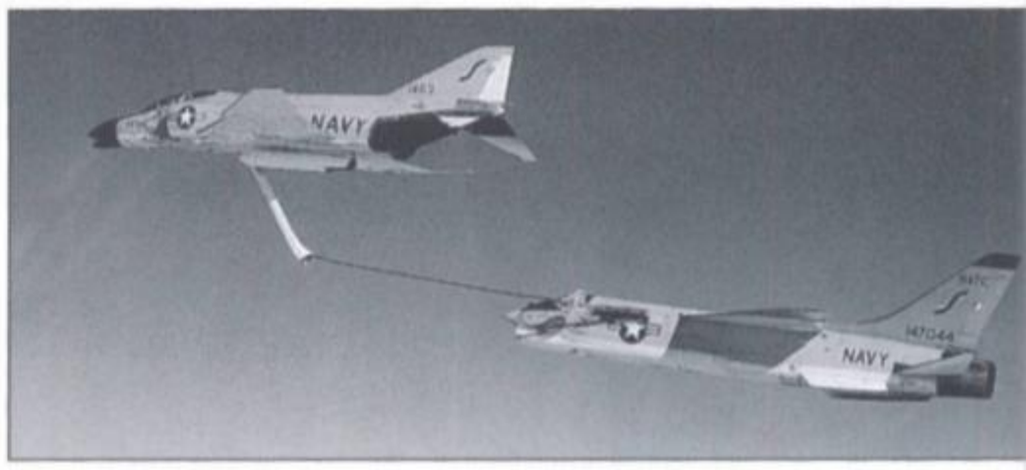
The APC was engaged only with the Crusader's wing in the 'up' position, and would automatically disengage upon landing. The system detected deviations in normal acceleration and angle of attack which would result in a less-than-optimum approach airspeed. During a normal approach, the APC could maintain airspeed with a range of plus or minus 4 kt (7.4 km/h), in light to moderate turbulence. By 1967, when the Crusader had been in the fleet for 10 years and was in combat in Vietnam, the APC was an accepted part of the aircraft's operation.

The Crusader models

The initial production F8U-1 Crusaders (later F-8A) were the last dedicated, clear-weather, gun-armed air superiority fighters to serve with the US Navy. As missions became increasingly complex, so did the aircraft to fly them. The 315 F-8As carried four 20-mm cannon, with 144 rounds per gun, right below the cockpit, two on a side, and two AIM-9 Sidewinder air-to-air missiles on fuselage cheek rails, one per rail. Besides the guns and missiles, the first Crusaders carried an unusual rocket pack in the speed brake, which swung down directly below the fuselage. (The large brake became the bane of any inattentive Crusader pilot, no matter how much time he had. Any aviator could forget to raise the brake prior to touchdown and subsequently land on the metal slab, much to his embarrassment and the probable anger of his commanding officer and maintenance crew.)

Below right: This Crusader was an NF-8D which served with the Naval Air Test Center at Patuxent River on trials duties. Here it refuels from an F-4B equipped with a trial tanking installation.

Below: VF-32 had operated the F8U-1 and F8U-1E before acquiring the F8U-2N in 1960 as one of the first units equipped with the variant.



F8U-2NE

The ultimate US Navy version, the F8U-2NE had a larger radar in the form of the APQ-94, resulting in a bulged radome. The aircraft had full air-to-ground capability, including the ability to launch AGM-12 Bullpup missiles, the avionics for which were housed in a bulged fairing on the aircraft's spine.

A test F8U-2NE from the NATC prepares to launch during carrier trials with the Mk 84 2,000-lb bomb and eight Zuni rockets. The F-8 was for many years the only fighter capable of carrying the large bomb.

The rocket pack carried 16 Mighty Mouse 2.75-in folding-fin rockets (FFARs) in eight tubes, and was supposed to be used in anti-bomber attacks, or for ground attack work. However, as the F-8 began to carry bombs and more advanced radar, the rockets were abandoned due to weight considerations, as well as their questionable effectiveness. The F-8A experienced problems with its guns, which gave too wide a dispersion of bullets. Even acknowledged gunnery experts among the Crusader cadre achieved limited results during training runs. The Colt Mk 12 cannon had a rate of fire of 660 rounds per minute, approximately 13 seconds of sustained fire. With the eventual addition of electronic countermeasures gear in the nose, the F-8 series had little expansion space for increased ammunition. It was a problem never satisfactorily solved.

Jamming guns

In combat in Vietnam, several pilots were frustrated by ammunition jams during high-*g* manoeuvres. Since ground strafing became an important part of the Crusader's repertoire in Vietnam, there was much concern. The small amount of ammunition did not give much strafing time for the F-8. A partial solution came from VF-124, the Miramar-based training squadron. The squadron rewired the gun circuitry to provide two switches in the cockpit. The pilot could select which pair of guns he wanted to fire, thus conserving his ammunition. Vought endorsed the change in the fleet, although Navy maintenance facilities did not like the unofficial modification. In time, the mod was officially sanctioned.

Missile wiring and switchology also caused occasional problems. A-4 pilots on Vietnam alpha strikes were concerned about their Crusader escorts' Sidewinders. The 'Scooters' dreaded the call "Fox away!" from the F-8s above them. The cry meant there was an AIM-9 loose – inadvertently fired – among the bombers. Going 'feet dry' (headed inland toward the target), the F-8 pilots turned on their Master Arm switches and any stray voltage could fire a Sidewinder.

The F8U-1E (F-8B) carried AN/APS-67 radar, replacing the F-8A's earlier APG-30 gun-ranging fire control apparatus. The new installation gave very limited all-weather capability. The F8U-1E made its first flight in September 1958, and kept the A's armament, including the ventral rocket pack, although most squadrons flew with the pack sealed. F-8B production totalled 130.

The first true fleet Crusader fighter was the 'Charlie', which flew in August 1957 as the F8U-2. It used a new engine, the Pratt & Whitney J57-P-16, which gave 13,000 lb (57.83 kN) of thrust in basic engine, and 17,500 lb (77.85 kN) in afterburner, which was 1,000 lb (4.45 kN) more than the earlier powerplants. F-8 performance increased, as did the afterburner's temperature. To help cool the aft section of the aircraft, two air scoops were mounted on the F-8C's tailcone.

Another characteristic feature of the Crusader line also appeared on the C model: the fuselage ventral strakes which were supposed to increase directional stability at high altitudes. The effect of these strakes was questionable, however, for several pilots consulted noted no change, but the fins remained for the rest of the F-8's career. The F-8C also gained two additional Sidewinders, which could be carried with a newly developed 'Y' rack. However, the four-missile armament was seldom carried in combat. The pilots felt that the weight penalty and reduction in fuel load was not worth the extra missiles.

A development of the F8U-2 was the -2N, eventually redesignated F-8D. Many pilots considered the D model, with its powerful J57-P-20 engine delivering 18,000 lb (80.07 kN) of thrust in afterburner, to be the fastest Crusader. Although it equipped several fleet squadrons by 1965, and saw heavy action (albeit with only two Navy squadrons, VF-111 and VF-154) in the initial phases of direct American involvement in Vietnam, it was quickly superseded by the definitive E model. Originally intended

Far left, bottom: Based at Miramar, VF-124 was the Pacific coast training unit for the Crusader. It received F8U-2NEs at an early date.

Left: F-8Es of VF-53 rest on the deck of* Ticonderoga*. The wing pylons were easily removed for operations in the fighter role.

Below: A quartet of F-8Es from VMF(AW)-312 flies over the San Bernadino mountains from the unit's home base at MCAS El Toro. The ground attack capability of the F-8E was to be greatly appreciated by the Corps when they went to war in Vietnam.

Remanufacture

To prolong the service life of the Crusader, Vought embarked on a major rebuild programme in 1965. Most existing aircraft were upgraded, beginning with the RF-8As (becoming RF-8Gs) and then tackling the fighter types. All of the reworks included rewinging the aircraft for extended fatigue life, adding boundary layer control and fitting a larger tailplane to maintain pitch control authority at the slower approach speeds made possible by fitment of the BLC. Of the production models, only the F-8A was not considered worthy of modification, although sizeable numbers of Bs and Cs were upgraded to K and L standard.

This Crusader was the first F-8D to emerge from the rework programme as an F-8H. Apart from the principal features of the modification programme (BLC, large tailplane, rewinging), the F-8H could be identified by the dorsal avionics hump which provided Bullpup launch capability.

***Opposite page, top: From 1968 to 1975 VF-194 'Red Lightnings' flew the F-8J, becoming the last fleet fighter Crusader unit. Proudly wearing the Battle 'E', this aircraft is seen taxiing on the deck of* Ticonderoga.**

Eighty-nine F-8D models were remanufactured to become F-8Hs in 1967-8. Only three Vietnam cruises were made with this version, but none by VF-211, one of whose F-8Hs is seen here. This aircraft went on to serve with reserve squadron VF-202.

to be a night-fighter, the F-8D featured improved radar and avionics as well as the addition of the Approach Power Compensator. It retained the four-cannon armament and the four-Sidewinder capability, but finally did away with the speed brake-mounted rocket pack. The first of the 152 F-8Ds flew in February 1960.

With the introduction of the F8U-2NE (later F-8E), the Crusader had developed from a lithe gun-toting dogfighter to a broad-shouldered, powerful jack-of-all-trades, in one moment a fleet defence fighter and bomber escort, next, a screaming dive-bomber, destroyer of river barges, trains and flak sites. The E model also made the greatest number of Crusader MiG kills in Vietnam (11).

The F-8E was essentially an improvement of the F-8D, featuring improved radar and engine plus additional avionics to fire the Bullpup air-to-ground missile, which in the event was rarely used. The F-8E also included two underwing pylons, and for a long time was the only fighter capable of carrying a Mk 84 2,000-lb bomb. First flight for the F-8E was in June 1961, and 286 were produced.

The remanufacturing programme

In reality, the F-8E was the last model of the original F-8, and the RF-8A was the only photo-reconnaissance variant; thus, there were only six basic versions of the Crusader. With the growing intensity of the Vietnam War in the mid-1960s, the Navy decided to keep in operation many of its ageing, smaller '27 Charlies' like *Hancock*, *Oriskany*, *Intrepid*, *Ticonderoga* and *Shangri-La*. Normal operational attrition, as well as heavy combat, had begun to deplete the number of available Crusaders.

The Vought Aeronautics Division of the now-renamed Ling-Temco-Vought (LTV) company was therefore tasked to refurbish existing airframes, reconditioning them and, in many cases, re-equipping them with later avionics suites. The letters G through M were allotted for these remanufactured F-8s, with the letter 'I' omitted.

The most significant modification to all the models was the installation of a wing with a service life of 4,000 hours, as well as a longer nose landing gear strut. Two inches (5 cm) longer than the original struts, the new nosegear could absorb 10 per cent more energy. All the modified aircraft received stronger main gear, too.

Another major addition was Boundary Layer Control (BLC), which first appeared in French F-8s. BLC provides additional lift during take-off and landing by routing engine bleed air over the upper surface of the flaps and ailerons. This permits the aircraft to be flown more slowly and thereby improves the aircraft's performance around the carrier. An extensive change, the BLC required internal ducting, a reduction in angle of wing incidence, and a larger Unit Horizontal Tail to give adequate longitudinal control at the lower landing speeds.

Photo-bird upgrade

Actually begun in 1965, the first remanufacture concerned the RF-8A. The early photo birds – 144 of which were built – were given updated avionics, navigational equipment, new cameras and the ventral fuselage strakes. Seventy-three RF-8As were eventually modified to RF-8Gs. The first group of 53 was refurbished from 1965-67, and the second batch of 20 in 1968-70. The RF-8G was ultimately the longest-lived US version of the Crusader, and gave sterling service throughout its long career.

Eighty-nine F-8Ds were remanufactured as F-8Hs, beginning in July 1967. The H models included underwing pylons and the Bullpup fire-control systems, identifiable by the hump over the wing. A sub-H variant was the F-8P, 35 of which were sold to the Philippines in 1977.

The last major fleet version of the fighter F-8 was the F-8J, a remanufactured F-8E. J model production totalled 136. It was the F-8J that saw the introduction of BLC into US Crusaders, the French having incorporated the system into their new F-8Es in the mid-1960s. F-8Js were the main fighter Crusaders on station during the last 18 hectic months of Vietnam, although none scored a confirmed MiG kill. The F-8K and L were remanufactured Cs and Bs, respectively, 87 F-8Cs and 61 F-8Bs being remanufactured. They were largely flown by Marine squadrons, although a few Navy utility squadrons operated these later models. The F-8K and F-8L featured underwing pylons and new cockpit lighting. The F-8M was a stillborn proposal to remanufacture low-time F-8As, few of which could be found by that time.

It should be noted that the US Navy adopted similar remanufacturing programmes for two of its other major

performers, the A-4 and F-4. While the A-4 programme only saw limited success – most of its remanufactured aircraft ended up in reserve squadrons – the F-4 Phantom achieved a virtual second life, remanufactured F-4Bs (as F-4Ns) and F-4Js (F-4Ss) serving in Navy and Marine squadrons through the mid-1980s. Who says only the Russians get their money's worth?

In 1967, a small number of F-8As were converted for drone controller duties, with the designation DF-8F. Utility squadrons such as VC-7 and VC-8 operated these unique aircraft, which were usually painted in bright colours and retained their 20-mm cannon armament.

A related control-aircraft designation was the QF-8A, occasionally called DQF-8A. Two of these controller Crusaders were operated by the Naval Missile Test Center at Point Mugu, California, and were used to track the Regulus II, a submarine-launched guided missile. Both the DF-8F and QF-8A had knobs and switches in the cockpit that let the Crusader pilot fly the Regulus.

In 1957, Vought installed a rocket engine in the tail of two F8U-1s, numbers 16 and 23. Built by Reaction Motors in New Jersey, the XLF-40 provided 8,000 lb (35.59 kN) extra thrust to the 10,000 lb dry/15,000 lb afterburner (44.48/66.73 kN) of the normal J57 jet engine. The XLF-40 was fuelled by a highly volatile mixture of hydrogen peroxide and jet fuel (JP). Unfortunately, the rocket engine blew up during early tests, killing two company mechanics, and Reaction Motors pulled out of the project. Vought continued the project using a Rocketdyne XLF-54 engine, which gave 6,000 lb (26.69 kN) thrust. Although the project never reached flight status, dummy engines were installed above the F8U-1s' tailcones, beneath the rudder. The purpose behind the rocket-assisted Crusader was to provide the F8U with extra power to reach any high-flying Soviet bombers which might appear above 60,000 ft (18288 m).

The 'Two-sader'

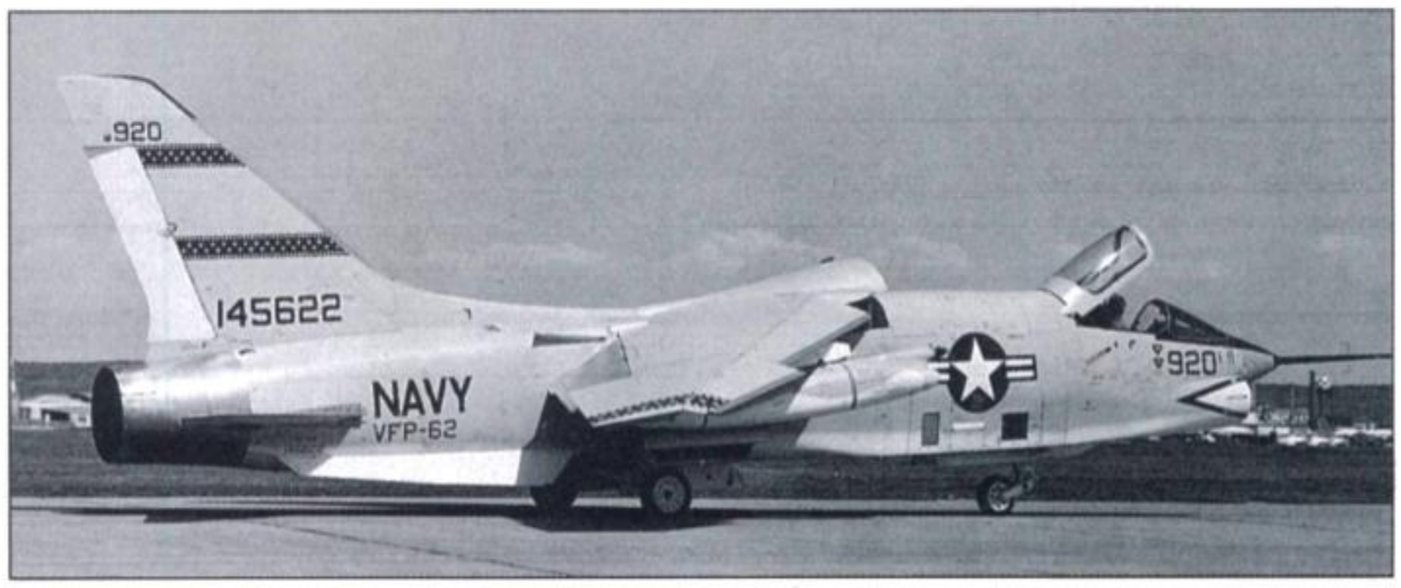
Perhaps the most drasticmodification of the basic Crusader fighters was the two-seat trainer, only one of which was built. Originally designated F8U-1T, and later TF-8A, it was designed to provide new F-8 pilots with a suitable trainer to make their transition to the Navy's first supersonic fighter easier. The F8U-1T, dubbed the 'Two-sader', was the 77th production F8U-1. The fighter was lengthened by 2 ft (0.60 m) and a second seat was installed, with a full set of flight controls. Two cannon and ammunition were deleted to make room for the second cockpit. The trainer was the only F-8 to carry a parabrake, located in the tailcone.

The first flight came in February 1962, and Vought then used the two-seater as a demonstrator during a European tour. The British were interested, and would have powered their 'Two-saders' with their own Rolls-Royce Speys, offering 2,000 lb (8.9 kN) more thrust than the J57-P-20 installed in the -1T. However, the British decided to buy the F-4, and Vought gave the trainer to the Navy's Test Pilot School at Patuxent River. After several years at the Maryland test site, the TF-8A went to the National Air and Space Administration (NASA) at Langley, Virginia, then to Edwards AFB, California.

When Vought got a contract in 1977 to provide refurbished F-8Hs to the Philippines, the trainer was regained from NASA to provide transition training for the Philip-

A few F-8Js remained in second-line service after the retirement from the fleet. Seen in 1977, this F-8J served with the Pacific Missile Test Center at Point Mugu.

Still wearing its RF-8A titles, this is a reworked RF-8G, seen carrying the rare underwing pylons and an ECM pod. The chief external difference of the G was the addition of underfins.

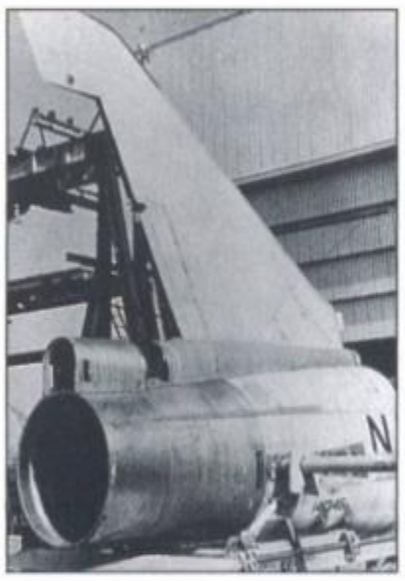


Drone controllers

Left: This DF-8F served at the Naval Weapons Center, China Lake. The large Dayglo panels were for conspicuity.

Below left: This VU-7 DF-8F from Miramar displays the standard blue/ Dayglo/yellow scheme employed by the drone controllers.

Below: The DF-8Fs were converted from F-8As. The blade antenna behind the cockpit was part of the drone control equipment.



Vought tested a Reaction Motors XLR40 rocket motor in the tail of an F8U-1 but an accident prevented the installation ever flying.

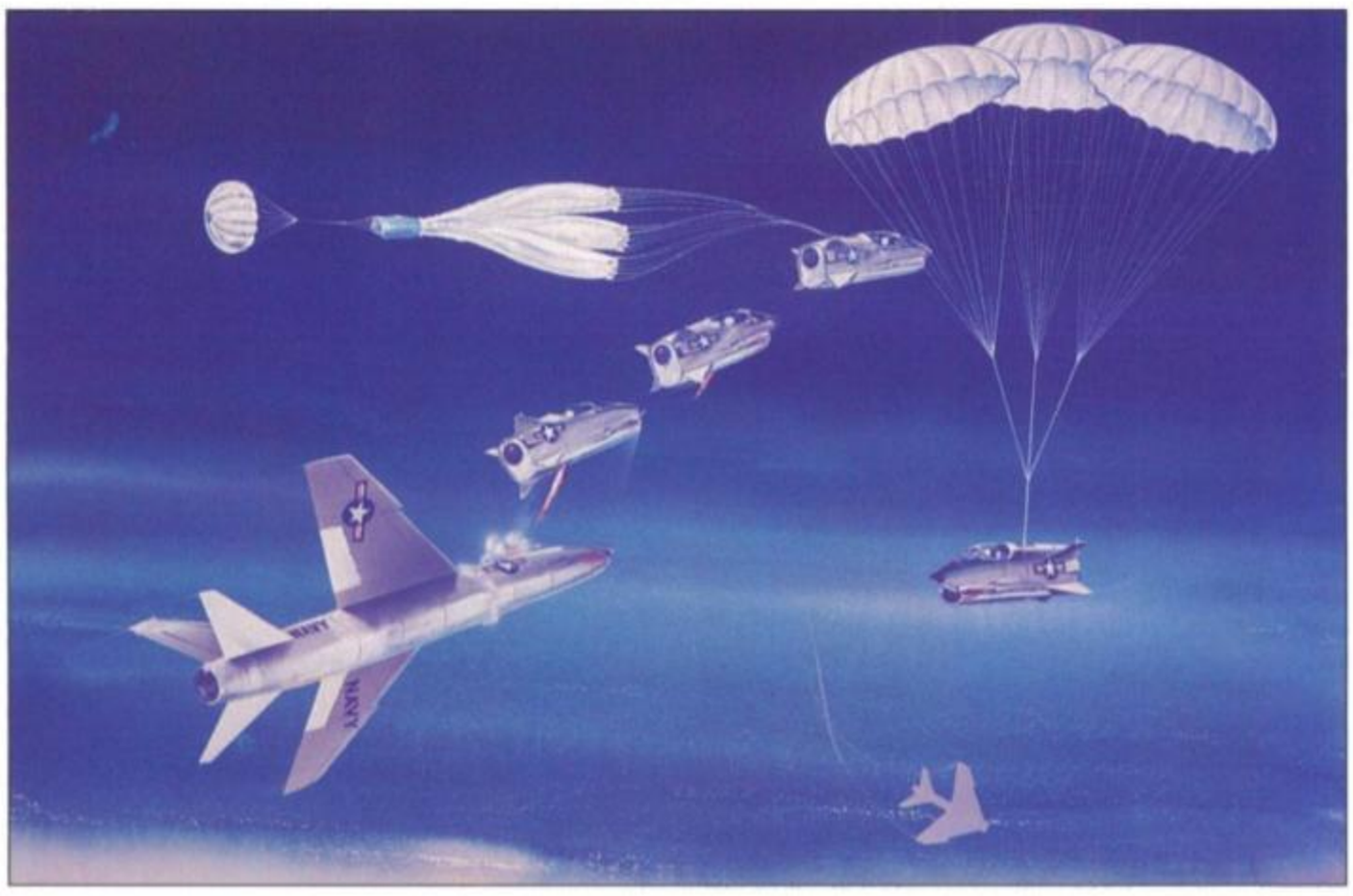
Another proposal was the fitment of a rocket-powered severing nose escape capsule. This was to have deployed pop-out fins for stabilisation.

pine air force pilots. However, the T's long career came to an end on 28 July 1978, when Vought pilot Ken Fox and Philippine Lieutenant Pascualito Ramos had engine trouble and had to eject, leaving their aircraft near Dallas. The TF-8A crashed in a farmer's field, ending its 16-year career.

War in Southeast Asia: the first combat

As the war in Vietnam grew in intensity, the US found its interests lay in supporting the South Vietnamese government. This meant not only furnishing specific supplies and material, but training the South Vietnamese and maintaining a large task force off the long Vietnamese coastline in the South China Sea. Before the climactic Gulf of Tonkin Incident of early August 1964, US carriers steamed north and south in support of various land-based operations. The main operation involved aerial reconnaissance using specially-configured RA-3B Skywarriors and RF-8As of VFP-63 detachments. Laos, which had been under direct Communist attack, was of special interest.

To demonstrate American concern, Air Force and Navy reconnaissance aircraft began flying low-level photo runs over the Plain of Jars and along the Laotian panhandle. *Kitty Hawk* (CVA-63) had three RF-8As and two RA-3Bs. Early on the morning of 21 May, two of its photo-Crusaders launched for a road reconnaissance. One of the RF-8s was hit by ground fire and began to burn fiercely but the pilot, Lieutenant Charles F. Klusmann, managed to return to his carrier.



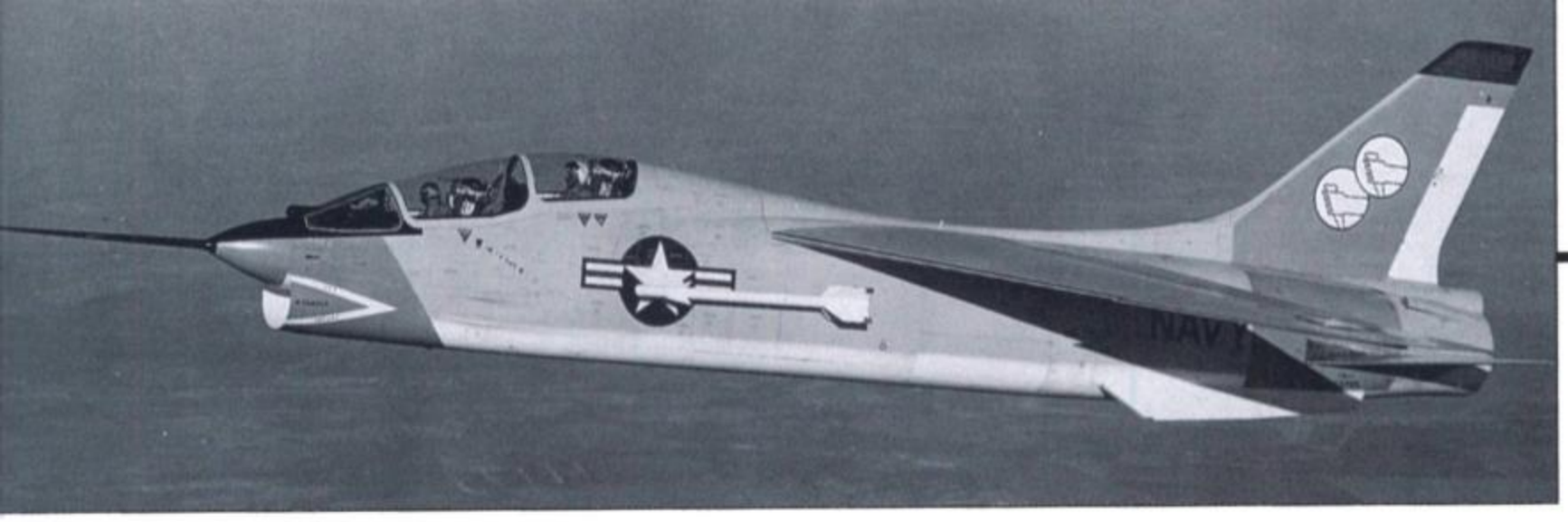
The 'Essex'-class carrier *Bon Homme Richard* (CVA-31) brought three more RF-8As, along with two RA-3Bs. Four Marine RF-8As from VMCJ-1 were also included in beefing up reconnaissance assets. Navy and Air Force aircraft made more than 130 flights over Laos in three weeks, from 21 May to 9 June. On 6 June Lieutenant Klusmann's aircraft was again hit by anti-aircraft fire. This time, the damage was too severe for a safe return, and Klusmann ejected from his Crusader, the first combat ejection from an F-8. It was to be only the first of many.

Klusmann was captured by Laotian Communist forces and endured three months of torture before he could escape, and eventually make his way to friendly forces. He was awarded the Distinguished Flying Cross, and his experience alerted US commanders to the dangers awaiting American flight crews who parachuted into Communist captivity. The manner in which a US aviator should, or could, conduct himself under extreme mental and physical torture became an important, if largely insoluble, problem throughout the long war in Vietnam. Klusmann's experience barely hinted at the horrible times in store for his fellow aviators.

The Gulf of Tonkin Incident, August 1964

The South Vietnamese had been making small commando raids on enemy bases along the Chinese coast and on offshore islands. The US had instituted a standing destroyer patrol, codenamed De Soto, which collected electronic intelligence. The patrol was extended to include the North Vietnamese coast, even though both Communist countries were known to be quite unhappy about this offshore surveillance.

The August 1964 De Soto patrol included the *Ticonderoga* (CVA-14), one of the smaller '27 Charlie' carriers. Its aircraft would be on immediate call to protect one of the destroyers, USS *Maddox*. That ship was attacked early on the morning of 2 August after passing close to the North Vietnamese island of Hon Me. Communist PT boats came out from their nearby base and made runs on the American destroyer. Although nothing came of these early feints, another sortie by the PT boats in the afternoon resulted in a torpedo attack on the *Maddox*. Four F-8Es from VF-51 and VF-53, already airborne, were sent to the scene of the attack. Armed with Zuni rockets and cannon, the F-8s went after the North Vietnamese boats, which fired back, hitting one of the Crusaders. Its pilot, Lieutenant (jg) Dick Hastings, made an emergency landing at Da Nang. While



Two-seat Crusader

Having been built as a standard F8U-1, BuNo. 143710 was first converted to XF8U-2NE status before becoming the sole XF8U-1T two-seater. The aircraft was lengthened to accommodate the second, raised cockpit, and some internal rearrangement (and the deletion of two cannon) was required. The aircraft had a lengthy career as a demonstrator and as a test pilot trainer.

Above: Adorned with a two-stick tail logo, the F8U-1T (TF-8A) first flew in February 1962. As the Crusader had flown with the US Navy since 1956, the service had already demonstrated the ease of transition without the use of a two-seater.

The TF-8A did undergo some carrier trials, performing some touch-and-go approaches as well as traps and cat launches. A Rolls-Royce Spey-powered version was offered to the Royal Navy to answer its requirement for a carrierborne fighter-interceptor, although in the event the F-4K Phantom was chosen.

Left: Photographed in 1973, the TF-8A wears the logo of the US Navy Test Pilot School, to which the aircraft was assigned after its demonstration days were over. It subsequently went to NASA at Langley and then Edwards before being reclaimed by Vought. It crashed in 1978.

Below: The 'Two-sader' is seen in flight in the mid-1970s while operating out of Patuxent River. A unique feature of this aircraft was the fitment of a brake parachute, located in the fairing at the base of the fin.

the VF-51 F-8s, led by the CO, Commander James Stockdale, and Lieutenant Hastings, attacked two PTs, the two VF-53 Crusaders (Commander Robair Mohrhardt and Lieutenant Commander Charles Southwick) hit a single PT with Zunis and then cannon fire. The boat stopped and began to burn; it eventually sank.

A second North Vietnamese attack two days later, this time at night, against *Maddox* and *Turner Joy* brought increased American indignation, and more direct action from *Ticonderoga* aircraft. Whether this second attack actually took place has been the subject of discussion since the war. The question will probably never be resolved to everyone's satisfaction.

Pierce Arrow

On 5 August aircraft from the *Constellation* and *Ticonderoga* launched Operation Pierce Arrow, a strike against PT boat bases. Along with A-4 and A-1 bombers, F-8 escorts and two RF-8As made up the first strike group from 'Tico'. A second group from 'Connie' launched 45 minutes later. While the attack headed toward its targets, President Lyndon Johnson went on American television to address the American people. Many people in the military felt the President's speech alerted the North Vietnamese long before it was necessary, and their defences were ready for the US aircraft. Although no Crusaders were shot down, two bombers were destroyed. Lieutenant (jg) Everett Alvarez Jr, of VA-144, ejected from his A-4C after taking a hit, and became the first POW since Lieutenant Klusmann's capture. He remained in captivity until 1973. Lieutenant (jg) Richard Sather, an A-1 pilot from VA-145, was shot down and killed during the attack, thus becoming the first naval aviator to die in the Vietnam conflict.

A gigantic build-up in air, sea and land forces began as America flooded Southeast Asia with overt support. Eventually, the crisis atmosphere of the August and September incidents subsided, and the South China Sea was quiet for a time. However, the attitude of the US had greatly changed, and preparations began for a wider war.

In December, a programme of armed reconnaissance and strike missions – codenamed Barrel Roll – began against specific Communist facilities along various road networks. The first Barrel Roll mission was flown on 17 December by four A-1 Skyraiders and four F-4s, followed by two RF-8As, all from Air Wing 9 in the USS *Ranger* (CVA-61). Initially, the Barrel Roll missions yielded little, but the programme continued into 1965, and eventually began uncovering the extent of the massive Communist supply operation along the incredible network of trails and roads called the Ho Chi Minh Trail.

The Crusader's role during this early period of Vietnam combat was mainly reconnaissance. Fighter F-8s performed escort duties or delivered Zunis against selected ground

Above: An F-8C from VF-194 in Bon Homme Richard *fires a Zuni rocket at a Viet Cong target during 1964. Many of the targets for this weapon were the small ships used to infiltrate supplies along the coastline to the guerrillas in the south.*

Right: Photographed in March 1966, this dramatic picture was captured by a VFP-63 RF-8G as a VF-53 F-8E lets fly with a Zuni against river traffic. The rocket came in several varieties with different motors and warheads. The old Mk 16 had folding fins while the later Mk 71 had wrap-round fins.

Rocket attack

During the opening rounds of the Vietnam War the F-8s were active on rocketing attacks. These used the 5-in Zuni rocket fired from launchers attached to the fuselage missile pylons (either two or four on each side). The Zuni was highly effective, and could be aimed highly accurately during a shallow dive. The weapon was used against shore targets and small vessels.

targets, but it was the RF-8As of the various VFP-63 detachments, along with Marine RF-8s of VMCJ-1, that performed the greatest service. VMCJ-1 had been alerted several times earlier in the year to be ready to deploy to Southeast Asia on eight hours' notice. After the Gulf of Tonkin Incident, the squadron sent two RF-8As and 15 men to the *Constellation* by way of Japan and the Philippines. When the 'Connie' left the war zone, its Marine reconnaissance detachment transferred to the *Bon Homme Richard*. During a photo mission, Captain L. J. Draayer overflew an enemy gun emplacement. One of the Navy pilots who had been escorting him was shot down, and Captain Draayer overflew the crash sight to see if the Navy pilot was all right. Although the Navy pilot eventually was recovered, Captain Draayer received a "royal dressing down" for endangering his photos.

Marines afloat

A second detachment relieved the 'Connie'/'Bonnie Dick' detachment on 29 September. The newcomers received their indoctrination to shipboard life from their Navy hosts in VF-194. The Marines found life aboard the World War II-era carriers less than ideal. A lack of air conditioning, coupled with water restriction, made the close atmosphere a test of endurance for everyone. However, the three VMCJ-1 dets provided a measure of relief for the hard-pressed Navy photo dets. And, when there were not enough Marine aviators, the Navy 'borrowed' its Leatherneck cousins' aircraft.

As the build-up of American forces in Southeast Asia began in earnest following the Gulf of Tonkin Incident, F-8s served in every carrier in the South China Sea, at least in the reconnaissance role, and, in the case of the smaller carriers, in the fighter role as well. While the larger ships included F-4B Phantom squadrons as their primary fighter complement, the smaller decks made full use of the F-8's bomb-toting capabilities.

Even though the military situation in Vietnam had eased following the sporadic strikes of late summer, a Communist attack on American and South Vietnamese facilities in February 1965 brought increased US response. A programme of regular bombing raids codenamed Rolling Thunder began in February. The carriers *Coral Sea*, *Hancock* and *Ranger* contributed their aircraft to attacks on North Vietnamese bases.

Lieutenant (jg) (later Rear Admiral) Tom Irwin, a young F-8C pilot with VF-24, flew De Soto patrols in December and January, and participated in the 7 February 1965 strike into North Vietnam, followed four days later by another raid on the Chan Hoa barracks near Dong Hoi airfield. He recalled the early days of the war. "By the middle of March 1965, daily strikes had become routine. At this time the

Far right: An F-8D of VF-111 follows another on to the catapult of Midway *prior to a 1965 fighter mission over South Vietnam. Unusually, the 'Sundowners' were not partnered by another Crusader squadron during their cruise with Air Wing 2.*

Right: VF-51 (illustrated) and VF-53 were aboard Ticonderoga *for the 1964 South China Sea cruise. On 2 August 1964 Crusaders from both squadrons fired the F-8's first shots in anger in response to the North Vietnamese attack on the USS* Maddox.

Left: Seen on combat duty in 1965, a VF-162 F-8E taxis past the aircraft of Air Wing 16 on board Oriskany. *In the background are F-8s of VMF(AW)-212.*

Below: After earlier flying the F-8D in combat, VF-111 returned to Southeast Asia in mid-1967 with the F-8C, partnering VF-162 aboard Oriskany.

strikes were handled as ship-wide strikes, with a big one for the day. They had all the support elements – tankers, weather, recce, AEW, CAP – and, on occasion, flak suppression with Zunis.

"The CAP were armed with 400 rounds of 20-mm and two Sidewinders, sometimes four later on. One problem for the F-8Es in VF-211 was that if they returned with all four Sidewinders, their maximum landing weight dictated a max fuel load of 1,200 lb, usually at or below bingo. So we sometimes ended up with the F-8Es flying lead, using their better air-intercept radar, while we in the 'Charlies' were the actual CAP. The 'Charlies', without hardpoint wings, could come aboard with the four 'winders and 2,500 lb of fuel because of their lighter basic weight."

Hancock's two F-8 fighter squadrons, VF-24 and VF-211, flew different models of the Crusader. VF-24 flew the F-8C in the traditional escort and CAP roles. VF-211 also used its fighters as escorts and, in fact, became the first US fighter squadron to encounter North Vietnamese MiGs, on 3 April 1965, when MiG-17s intercepted a bombing raid on the Thanh Hoa Bridge. One VF-211 F-8E was damaged. The 'Checkmates' of VF-211, who had obtained their 'Echoes' in February 1964, used their fighters against ground targets.

Delta at war

The 'Black Knights' of VF-154, in *Coral Sea*'s Air Wing 15, were one of only two squadrons flying the F-8D from carriers in Vietnam, the other being VF-111. VF-154 was also one of the first Navy Crusader squadrons, having received its F-8As (F8U-1s) in early 1957. The squadron had participated in deployments to the troubled Formosa Strait in 1958 when a brief war between Communist China and the Taiwanese government threatened peace in the area. VF-154 flew from the *Hancock*, ready to take on the Communists should the efforts of the Taiwanese air force prove futile. However, direct US assistance was not needed.

During *Coral Sea*'s 1965 Vietnam cruise, VF-154 lost five Crusaders to enemy action, including three in four days. VF-211 had not lost any aircraft to the intense ground fire. The 'Checkmates' said that the 'Black Knights' were using peacetime delivery tactics – 80 per cent power, speedbrakes out, at 250 KIAS. VF-211 told VF-154 pilots to make their runs as fast as possible. However, the 'Black Knights' refuted this recommendation. It was to be VF-154's only cruise with the F-8. The squadron returned home after a record 331-day deployment, and transitioned to F-4Bs in November.

'Bonnie Dick' had also participated in the heavy combat of 1965, moving up and down the Vietnamese coast from Dixie Station to Yankee Station and back again as requirements dictated. Both fighter squadrons lost several aircraft during this cruise. VF-191 lost three F-8s to anti-aircraft fire, and one to a surface-to-air missile. VF-194 lost three to flak, and one in an operational mishap.

In 1965, USS *Oriskany* (CVA-34) undertook an event-filled combat cruise from May to November. Three different Crusader squadrons were included in Air Wing

Left: On 11 October 1965 Lt Jack Terhune of VF-154 made this successful ejection from his crippled F-8D.

Below: In April 1966 Lt Ron Ball's F-8 was hit by AAA, and he was picked up by an SH-3A. Note the personal flotation gear and survival radio.

F-8 Crusader

Above: Outbound on a mission over North Vietnam, a pair of VF-162 F-8Es joins up after launch. Both are carrying Zuni rockets on Y-racks.

Right: Lieutenant W. F. Flagg sits in his F-8E. Flagg flew with VF-162 during the busy 1965 cruise, and later rose to two-star rank in the Naval Reserve. He achieved the highest number of flight hours in the Crusader of any aviator: 3,200.

Top right: A MiG-17 manoeuvres hard during a fight with Crusaders on 14 December 1967. During this fight VF-162's Lieutenant Richard Wyman shot down one of the MiGs with a Sidewinder.

Photographed on 10 March 1965, a VF-111 F-8D from USS* Midway *makes a Zuni dive attack over South Vietnam. The aircraft is beginning to pull out of the dive, the* g *creating wingtip vortices.

16. VFP-63's Det G and VF-162 were the two Navy squadrons, flying the RF-8A and F-8E, respectively. VMF(AW)-212 was a Marine squadron, also flying the F-8E, having converted from A-4s in 1963. *Oriskany*'s original second fighter squadron, VF-161, flew F-3 Demons, which were being rapidly replaced in the fleet by Phantoms. To keep a common aircraft in the wing, for mission and maintenance considerations, the 'Lancers' were brought on board in January 1965.

In a unique turn of events, when Commander James B. Stockdale, commander of CVW-16, was shot down on 9 September during a strike, the most senior naval aviator in the wing was Lieutenant Colonel Charles H. Ludden, the CO of the Marine Crusader squadron. Commander Stockdale and Captain Bart Connolly, commanding officer of *Oriskany*, had agreed that Ludden, who was well-liked and respected by his peers, would take over CVW-16 in the event of Stockdale's departure. Thus, Air Wing 16 had a Marine as its leader until 4 October, when Commander R. E. Spruit assumed command.

VF-162: The 'Hunters' at War

Tuesday, 25 May 1965

"Well, at long last, I can consider myself to be a combat pilot, as I made my first strike today. I didn't see anyone shooting at me, but I did blow up a house..."

Lieutenant (later Rear Admiral) W. F. Flagg's letter to his wife told of his first mission in Vietnam, three weeks after *Oriskany*'s aircraft had fired their first shots in the 'O-Boat's' first combat cruise since the Korean War. He was a member of VF-162. Later, while acting as the squadron's quality assurance (QA) officer, he found that getting parts for the F-8s was a problem. However, the more the squadron flew its aircraft, the more the Crusaders remained operational. He decided this 'up' status was because of the hydraulic seals. Typically, F-8s always leaked hydraulic fluid, but the leaks became more pronounced if the individual aircraft did not fly regularly. The seals would dry out and become brittle and then, when the aircraft did fly, the seals would crack and the fluid would run out.

During the initial stages of the 1965 combat deployment, VF-162 pushed its fighter role because, quite naturally, all the squadron pilots wanted a chance at a MiG. Their Marine counterparts in VMF(AW)-212 assumed the role of the bombers, much to the amusement of the A-1 Skyraider pilots of VA-152. The A-1H drivers claimed they dropped more bombs on the catapult than the F-8s did on their targets. Eventually, the 'Hunters' assumed more bombing.

Flagg continues: "After the Tonkin Gulf Incident, we found the F-8 had a new role since we were the first F-8Es with the so-called hardpoint wings. We ended up carrying MERS and TERS, dropping bombs and shooting rockets. Up to now, everything had been done with the fuselage stations. We spent a lot of time at Fallon in the summer of 1964, learning how to drop bombs. For us fighter pilots, that was an experience in itself. I won't say we got proficient at dropping bombs, but we dropped our fair share that summer."

The guns

As the war intensified in 1966, with increased American attacks on Communist war-making industry such as POL (petroleum, oil and lubricants) facilities, so did the North Vietnamese defences, and they took a terrible toll of all American aircraft. Initially, the aircrews' main concern was the small arms fire. Every enemy soldier had a rifle or small machine-gun, and below 1,200 ft (366 m) these weapons could and did bring a aircraft down. By 1965, highly capable anti-aircraft cannon like the 23-mm, 37-mm, 57-mm and the huge 100-mm – usually found in the larger, more industrialised areas like Hanoi and Haiphong – could be fired with a high degree of accuracy. In fact, neither the missiles nor MiGs ever generated the same fear felt by US crews for the intense flak nests encountered over the North. Forty-two Navy F-8s and 20 RF-8s, and 12 Marine F-8s, were lost to flak and small arms fire.

Then-Lieutenant (jg) (later Rear Admiral) Jay Miller was an RF-8G pilot with VFP-63's *Coral Sea* detachment in

MiG-killers 1966

Above: Lt Gene Chancy of VF-211 scored a MiG-17 kill on 21 June 1966, using 20-mm cannon fire.

Right: Cdr Dick Bellinger of VF-162 – his camouflaged flight suit was obtained in a trade with an army unit. He shot down a MiG-21.

Above: VF-211's Cdr Hal Marr scored the F-8's first kill on 12 June 1966.

Right: Lt Phil Vampatella describes his MiG kill using the time-honoured fighter-pilot method.

1967. With 96 photo missions over the North, Miller was an experienced reconnaissance pilot. His respect for Communist flak never waned. "In September 1967, when we were going two or three times a day – the *Coral Sea*, the 'O-Boat', maybe the 'Handjob' (*Hancock*) – we were flying multi-Alpha strikes. There'd be one at 09.00 from our boat, one at 10.00, 14.00, 17.00, all on those bridges in downtown Haiphong. The light was still there at that time of the year."

On one mission, Miller covered a strike against northern Haiphong. Flak was intense, and he knew that everyone from the CAG to the admiral wanted to see the BDA photos. "As soon as I started getting close, they started firing. I felt that if I opened my canopy I could walk across Haiphong on all the flak. It was a perfect example of why you wanted to use afterburner over Haiphong.

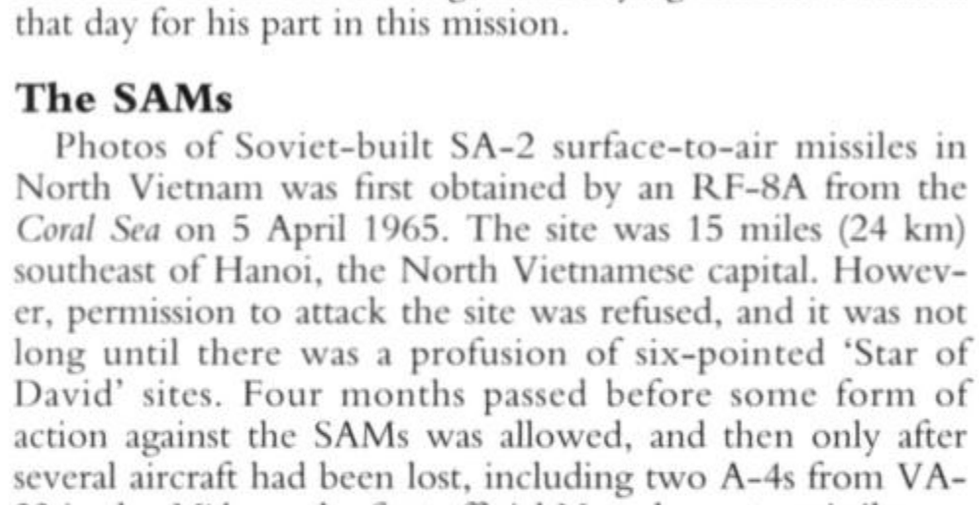
"I could see all this stuff coming up at me, and as I went into 'burner the nose began to tuck, and the aircraft climbed, just barely, over all this. I got the pictures, and they turned out pretty well. My escort told the CAG that I'd stuck in there and got the pictures." Lieutenant Miller received one of the Distinguished Flying Crosses awarded that day for his part in this mission.

The SAMs

Photos of Soviet-built SA-2 surface-to-air missiles in North Vietnam was first obtained by an RF-8A from the *Coral Sea* on 5 April 1965. The site was 15 miles (24 km) southeast of Hanoi, the North Vietnamese capital. However, permission to attack the site was refused, and it was not long until there was a profusion of six-pointed 'Star of David' sites. Four months passed before some form of action against the SAMs was allowed, and then only after several aircraft had been lost, including two A-4s from VA-23 in the *Midway*, the first official Navy losses to missiles.

Crusaders and Skyhawks formed a unique partnership against the SAMs, under the overall mission codename of Iron Hand. A-4s with AGM-45A Shrike missiles led their F-8 escorts in attacks against the sites. These attacks were extremely dangerous, because after the Navy enjoyed initial success with the beam-riding missiles, the Communists became adept at turning their fire-control radars off, thereby denying a target onto which the Shrikes could home. When the Shrikes were fired, the F-8s would follow the missiles right down toward the site, wait for missile impact, and then open up with their 5-in Zunis and cannon, creating a devastating one-two punch. Many Crusaders suffered major damage or loss during these SAM suppression runs; it was not a mission for the faint-hearted. The SA-2 was a 35-ft (10.6-m) long missile with 350 lb (159 kg) of high explosive in its warhead. Detonation within 200 ft (61 m) of an aircraft usually meant a kill. SAMs accounted for 10 Navy Crusaders.

Dudley Moore had a close encounter with a North Vietnamese SAM in 1966. It was one of those unusually clear days over Pak Six, almost brilliant, not unlike southern California. With Boyd Repsher in the lead, Moore crossed



Left: 'Tooter' Teague's VF-111 F-8D appears to devour a brownshirt as he checks the intake for foreign objects and damage. The F-8 was treated with great respect by deck crews as the low-slung, angled-down exhaust could easily blow an unwary man from his feet. The intake was voracious with the engine running, earning the aircraft the nickname of 'The Gator' among the brethren on deck.

Below left: An F-8C of VF-111's Det 11 lands back on USS **Intrepid**. *The two-digit nose number is noteworthy.*

Below: A 'Checkertails' F-8E launches from 'Bonnie Dick' in May 1967. On the 19th of the month VF-211 scored two victories, while sister squadron VF-24 accounted for another pair of MiGs.

Above: A victorious LCdr 'Moe' Wright lands back aboard 'Bonnie Dick' on 1 May 1967, having shot down a MiG-17 during the mission (note the empty Sidewinder rail). Wright had been on an Iron Hand escort mission.

Right: VF-24 partnered VF-211 during the successful 1967 cruise. Flying F-8Cs, VF-24 had four confirmed kills and one probable. The deck crewman is signalling to the pilot to cut power.

***Right: During 1967 VF-111 operated detachments aboard different carriers with both F-8Cs and F-8Es. Here an F-8C launches from* Oriskany.**

Below: A VF-211 F-8E launches from USS* Hancock *in 1969. The squadron emerged as the highest-scoring F-8 unit, with seven confirmed kills.

the coast south of Vinh on a MiG sweep. A MiG in those days was a rarity, but there was always hope. After some loose-deuce manoeuvring, the two VF-194 Crusaders were down to bingo fuel, but they decided to make one more 180° before going 'feet wet'.

There was absolutely nothing going on, however, and they turned for home. Moore swung into a tactical-wing position. Suddenly, he spotted a large squirt of dust on the ground with a large orange plume rising out of the middle of the cloud. SAM launch! Simultaneously, Moore hit burner, raised his wing droops and keyed the mike. "Sheepdog, SAM lifting off at 9 o'clock. Get some speed on!" Repsher punched in his afterburner and pushed over in a 40° dive. The two F-8s were in a right bank, nose down, and accelerating. By now, Moore was at his lead's five o'clock, watching for the missile.

Both pilots had already seen many SAMs in flight, but this was the first time they had a ringside seat watching the full launch sequence. The SAM was at 3,000 ft (914 m) when the booster kicked off, and the tracking sequence began. But who was it locked on to? There was no way to tell. Moore flicked an eyeball toward the mach meter – 600 kt. He said to Repsher, "I'll call the turn."

The missile was at terminal velocity, shooting a 10-ft (3-m) flame, and coming fast. As it levelled nearly parallel to the ground, it became obvious that the SAM had locked on to Repsher. "It's on you, Rep. Break left, hard, now!" Everything seemed to slow down. The hardest part was waiting to time the hard roll so the missile was unable to match the turning angle.

Both pilots slammed on 6+ *g* as their noses went up and over, toward the vertical. The SAM was on them now. It was going to be close. As both F-8s rolled into the vertical, the SAM pulled off Repsher and headed between the two Navy fighters. As the F-8s rolled into the missile, the SAM was right by Moore's canopy. He watched bug-eyed as it zipped across his windscreen, so close he could see big dents on it. As he stared at this beat-up missile, all he could think was, "Bad QC (quality control)!"

The SAM flashed by as they rolled left, standing on left rudder. The Crusaders scooped out, and Moore watched the SAM out of his right side. The missile, with nothing to guide on, tumbled crazily and headed straight up. It climbed about 1,000 ft (305 m) and exploded in a huge cloud of black smoke and flame against the brilliant sky.

The MiGs

Although the flak and SAMs were by far the most effective part of the Communist defences, the traditionally more glamorous fighter-to-fighter encounters grabbed the headlines. Originally equipped with a mix of light transport aircraft, the North Vietnamese air force received MiG-15, MiG-17 and a few MiG-19 jet fighters from the Soviet Union and Communist China. By the time American

MiG-killers 1967

Above: Phil Wood preflights his F-8.

Left: From left to right are Shea, Speer, Wright and USAF exchange pilot Lord.

Above: Following the highly successful 1967 cruise, CVW-21 MiG-killers pose for the camera. From left to right they are Major J. A. Hargrave (USAF exchange, not credited with a victory), LCdr T. R. Swartz (A-4 pilot), Cdr Paul Speer, LCdr M.O. Wright, Lt (jg) Joe Shea, LCdr Bobby Lee and Lt Phil Wood.

Left: NP 443 was the VF-24 F-8C flown by Lieutenant Phil Wood the day he scored a victory over a MiG-17, rescuing an A-6 Intruder. Shot up and low on fuel, Wood recovered aboard **Kitty Hawk** *rather than 'Bonnie Dick'. The A-6 was from* **Kitty Hawk**, *and the Intruder pilot photographed the beat-up Crusader. The message reads 'A grateful A-6 pilot owes you a drink – Sam Sayer'.*

attacks began in earnest in 1965, the threat of MiG interception was very real.

As noted, North Vietnamese MiGs first appeared in early April 1965. The MiGs only damaged one F-8, but they shot down two Air Force F-105s the following day. Although there were several engagements between US and North Vietnamese aircraft, the Navy enjoyed few successes. The first confirmed Navy kills came on 17 July 1965, when two F-4Bs from VF-21 shot down two MiG-17s. Three days later, a MiG-17 was brought down by a flight of A-1s, one of two MiG kills scored by the old prop-driven Skyraider in Vietnam. However, a year passed before the next Navy victories, which would also be the first kills for the F-8. There were a few near-misses for the F-8 pilots, who had to deal not only with finding and engaging MiGs, but with a constantly evolving list of rules of engagement.

Ship control

Consider Bud Flagg's predicament. "We all wanted a MiG so badly we could taste it. I was under the control of a destroyer, working south of Hong Ghe. The destroyer told us there was an aircraft coming from Kep, one of the major MiG bases, and he vectored us to within five miles of the bogey, who turned and headed north.

"We lit the 'burners and chased him. But at this time, we weren't supposed to cross the 21st Parallel. Of course, in the air you can't tell what parallel you're crossing, and I was in hot pursuit. We were gradually closing on him; I had him on radar. On the APQ-94 radar scope in the F-8, there was a little mark which told you when you were in range for a missile shot. He was about one to two miles above that little mark and gradually coming down the scale. All I needed was another five to 10 minutes to close to get a shot off.

"But the destroyer yelled for me to break it off since I was approaching the 21st Parallel. I pushed it, until they really started screaming at me. I guess I actually did cross the parallel before turning around."

F-8 pilots claimed – with justification – that they flew the last gun-armed, air-superiority, single-seat fighter in naval service. Its successor, the F-4 Phantom II, carried an all-missile armament as a result of a decision in the 1950s to do away with guns in favour of the more sophisticated air-to-air missile. Originally a single-seater, the Phantom added another crew member to operate the aircraft's radar system: the radar intercept officer (RIO). Ultimately, the RIO's main contribution to the Phantom concept proved to be simply another pair of eyes to help the pilot during aerial engagements. It was not until the development of the Grumman F-14 Tomcat that the pilot truly needed a dedicated, specially trained crewman behind him to operate the weapons radar and to successfully undertake the fleet defence mission.

A friendly rivalry developed between F-4 and F-8 crews. While Navy Phantoms accounted for 36 MiGs and two An-2 'Colt' transports, and the Marines got one MiG in a Marine Phantom, the F-8 was credited with 18 confirmed

*VF-162 made five combat cruises in three carriers (***Oriskany, Ticonderoga** *and* **Shangri-la***). The 'Hunters' were credited with two confirmed kills, one by Dick Bellinger and one by Richard Wyman.*

F-8 Crusader

Squadrons changed ships occasionally whenever a carrier needed them. Although VF-51 normally cruised with the 'Tico' or 'Bonnie Dick', in 1967 it undertook one combat cruise aboard* Hancock. *Here an F-8E prepares to launch with a full load of four Sidewinders, somewhat rare since the two extra missiles imposed fuel consumption penalties.

Performing one of the most dangerous tasks in the Navy, the hook runner ensures the arresting wire is disengaged from the hook of this VF-51 F-8H aboard* Bon Homme Richard *in 1968. During this cruise the 'Screaming Eagles' used the 'Hotel' for two MiG kills.

Partnered with VF-211 in CVW-21, VF-24 made eight combat cruises. Ironically, the squadron's MiG successes all came during the one cruise made aboard 'Bonnie Dick': the other seven voyages were in* Hancock. *This is an F-8H, seen some time in 1969 being prepared for a photo-escort mission for a VFP-63 RF-8G.

MiG kills, as well as an occasional loosely credited kill in 1972. This last incident involved a MiG-17 pilot bailing out of his fighter as two F-8s approached. Although this 19th kill was not officially credited, it can be interpreted to highlight the Crusader's reputation: apparently, the MiG pilot had been told by his ground controller that the approaching American fighters were Phantoms, but when he saw their true identity he threw a few comments into the radio before ejecting.

It is interesting to note that all the Crusader's official kills came within a relatively brief two-year period, and after the last score on 19 September 1968 all US Navy MiG kills were by Phantoms. The main reason for this lack of additional Crusader kills, as any Crusader alumnus will confirm, was the lack of 'vectors' for the frustrated F-8 pilots. They spent the last three years of the war flying from the smaller carriers, largely relegated to ground-attack and occasional bomber escort duties, which meant staying with the bombers even with MiGs in the area.

The Crusader opened its score sheet on 12 June 1966, when Commander Harold L. Marr, commanding officer of VF-211, shot down a MiG-17 while flying escort for an A-4 strike. Watching the Skyhawks make their runs, Marr, his wingman Lieutenant (jg) Phil Vampatella, and another two-aircraft section of F-8s from VF-24, held at 1,500 ft (457 m) under clouds. As the bombers came off their target and rejoined their escorts, Vampatella called out MiGs approaching from behind at the seven o'clock position, at 2,000 ft (610 m). Marr recalled the fight.

"We pull hard into them and the fight's on. Two of the MiGs split off and we pass the other two head on. I fire a short burst of cannon at one MiG, more for courage than anything else – just to hear my four cannons bang.

"We're doing about 450 kt and pulling 7-8 *g* and reverse hard right in a sharp scissors. I get a good 90° deflection gun shot but my cannon misses again. Phil goes after one, and I go after the other. Now I'm at 2,500 ft at his eight o'clock and the MiG is down around 1,500 ft with nowhere to go. I fire the first of my two Sidewinders, but the missile can't hack it and falls to the ground.

"The MiG has been in 'burner for four or five minutes now and is mighty low on fuel, so he rolls and heads straight for his base. I roll in behind, stuff it in 'burner, and close at 500 kt. At a half mile, I fire my last 'winder, and it chops off his tail and starboard wing. He goes tumbling end over end. The poor pilot doesn't even have a chance to eject."

Having destroyed the MiG leader, Commander Marr then saw two other MiG-17s orbiting above him at nine o'clock, one grey and the other in the green-brown camouflage usually seen during the war. He climbed to 6,000 ft (1829 m) and engaged this second pair of MiGs, firing 25 to 30 cannon rounds. Marr saw fragments coming off the right wing of one of the MiGs, but he quickly ran out of ammunition and had to break off and could claim only a probable. An ecstatic Marr claimed the traditional victory flyby when he returned to the *Hancock*. The F-8 had gained its first kill.

Vampatella's and Chancy's kills

One of the most colourful Crusader-MiG engagements followed nine days later, and involved Marr's wingman on the 12 June fight, Phil Vampatella. On 21 June, 11 *Hancock* aircraft flew a strike into North Vietnam. The group was divided into two groups: a two-aircraft flight – an RF-8A and its VF-211 F-8E escort – which would make a reconnaissance run of the railway northeast of Hanoi, and six A-4s with three VF-211 F-8E escorts.

The strike group's three 'Checkmate' Crusader escort pilots were Lieutenant Commander Cole Black, Lieutenant (jg) Vampatella, and Lieutenant Gene Chancy. As the A-4s ran in toward their target, word came that the RF-8A flown by Lieutenant L. C. Eastman had been shot down. After making sure the A-4s were clear of their target, the three F-8s hastened to the site of the RF-8A's crash, taking radio cuts on the escort F-8E's radio transmissions. Lieutenant Commander Black and Lieutenant Chancy orbited over the site, while Lieutenant Vampatella took the wingman position for the photo escort, whose pilot, Lieutenant Dick Smith, had assumed the role of search and rescue commander. The four VF-211 F-8s remained at 1,500 to 2,000 ft (457 to 610 m) above the crash site.

The situation became complicated as the A-4s began calling out SAM launches and MiG warnings. The F-8s began to draw flak, 37-mm, 57-mm and probably 85-mm fire. Lieutenant Vampatella felt his aircraft shudder as he

From time to time in the Southeast Asia conflict, carriers were drawn in from the Atlantic Fleet to augment the hard-pressed Pacific Fleet vessels. While some Atlantic Fleet squadrons also saw combat, the Crusader deployments remained manned by the West Coast squadrons. When Shangri-la *and Air Wing Eight deployed to the South China Sea in 1970, the two Crusader squadrons were the long-serving VF-111 (F-8Hs illustrated) and VF-162.*

took a hit, but he remained on station for 10 to 12 minutes.

Lieutenant Smith and Lieutenant Vampatella saw the downed photo pilot's chute, and Lieutenant Commander Black and Lieutenant Chancy climbed to gain better radio communication with the incoming SAR helicopter. Upon reaching 6,000 ft (1,828 m), Chancy heard a SAM warning, and he and his leader remained at that altitude. Black asked about the F-8s' fuel states and ordered Smith and Vampatella to find a tanker. Black and Chancy orbited at 2,000 ft (610 m) above the RF-8. They spotted an orange signal flare, presumably set off by the photo pilot, about one-half mile from the crash site.

Then, Lieutenant Commander Black spotted two MiG-17s sliding in from the south, out of the clouds at the two o'clock position of the F-8s. The North Vietnamese fighters were very close, perhaps 0.5 mile (0.8 km) distant, and 500 ft (152 m) above the Crusaders. Black levelled his wings and began firing his cannon. The MiGs passed close to Chancy, their guns blazing. Chancy quickly fired his own guns as he crossed over his leader, left to right. The MiGs had apparently waited until the Crusaders had left their high-altitude station during the A-4 attack and were in orbit, at low fuel state, above the RF-8 on the ground. The F-8s would be at a disadvantage at such a low height, and also dangerously low on fuel.

Close-range attack

Lieutenant Chancy's desperate fire hit the MiG wingman as the section slashed through the Crusaders, and blew a wing off the MiG. "He was so close," Chancy later recalled, "I could have counted his teeth. It was a very effective attack." Chancy also got a harsh tone and fired one Sidewinder, but the missile failed to guide.

It would be a while before Gene Chancy's score would be changed from a probable to a confirmed kill, since the MiG was not actually seen to crash, and other participants in the fight were too busy or too distant to observe the action. However, Captain Jim Donaldson, commanding officer of the *Hancock*, told him to go to Saigon for the traditional press conference that followed every American MiG score. Finally, a Vought rep called Chancy to tell him he owed the lieutenant the special Vought pin that the company gave to Crusader MiG-killers. The lapel pin consisted of an F-8 silhouette with a red ruby.

Gene Chancy's kill has always been listed as a missile score; however, he is certain he downed the MiG with gunfire, especially since his single Sidewinder did not guide properly. This would make him one of only two Crusader pilots who could claim a guns kill. Unfortunately, Chancy's elation at his success changed immediately for he could not find his leader. Lieutenant Commander Black's F-8, BuNo. 149152, had been hit by the lead MiG and he had ejected. To Chancy's dismay, the SAR helo, originally sent to recover the RF-8 pilot, got lost and did not show up. Both Black and the RF-8 pilot were captured and remained POWs until 1973. Chancy had to leave his leader on the ground and return to the ship.

But the fight was not over. Upon hearing Lieutenant Commander Black call, "MiGs!" Smith and Vampatella had hauled their aircraft around and returned to the melée, even though Vampatella's F-8 was damaged. Nearing the action, they saw a section of two MiGs at 2,000 ft (610 m), in a diving right turn. Smith called a warning. "F-8, you have a MiG on your tail!" He could see the MiG's guns firing, followed by the F-8 bursting into flames. It was Cole Black going down.

A second MiG section then appeared and Lieutenant Smith tried to engage the leader, but his guns failed while in a high-*g* turn. Vampatella, meanwhile, had looked back to find another MiG on his tail, within gun range and firing. Vampatella tried to scissor with the MiG but had to limit his turns to 5 *g* because of the previous damage.

The MiG stayed with the F-8, and, although increasingly low on fuel, Vampatella lit his afterburner, disengaged from the MiG, and headed east at 600 kt (1106 km/h). Safe for the moment, he found that the Crusader was getting harder to fly. The MiG was more than a mile behind, and the North Vietnamese pilot seemed to have turned back toward home, probably low on fuel himself.

Seizing the opportunity, Vampatella reduced his speed and turned back toward the departing MiG. At approximately 0.75 mile (1.2 km), Vampatella tried one Sidewinder, then the second. The second finally came off the rail and guided straight toward the MiG, detonating

MiG-killers 1968

Right: Lt Tony Nargi (centre) scored the last confirmed F-8 kill on 19 September 1968. On the right is Alex Rucker, his wingman.

Below right: LCdr John Nichols (right) is congratulated by VF-191 skipper Cdr Tuomela after his 9 July 1968 MiG kill. He later became one of only five Crusader pilots to pass the 3,000-hour mark.

Below: Cdr Guy Cane of VF-53 indulges in a post-mission debrief of his 27 July 1968 kill.

Top and above: Two views show VF-211 F-8Js at war during the 1972 cruise in* Hancock. *The top photograph shows an aircraft on a CAP mission, with twin Sidewinder armament. In the lower picture a pair of Crusaders goes 'feet dry', crossing the Vietnamese coastline with bombs hung from the underwing pylons.

immediately behind the enemy fighter, which crashed.

After hitting the tanker with only 300 lb (136 kg) of fuel remaining, Lieutenant Chancy escorted Vampatella back to the *Hancock*, 60 miles (97 km) away. Vampatella tried to refuel, but the tanker could only give him only a bare minimum. It was uncertain if he could get back. However, he landed safely, and post-flight inspection revealed his aircraft had been hit in the vertical tail by 37-mm fire, and approximately 80 small holes dotted the F-8's rear surfaces. Phil Vampatella received the Navy Cross for his courage and skill, the second award of the Navy's highest decoration for Vietnam aerial action.

Cole Black's loss was one of only three confirmed F-8 losses to MiGs during the entire war. On 14 July 1966 a VF-162 F-8E, and on 5 September a VF-111 F-8E, were shot down by MiGs, and Air Force Captain W. K. Abbott, on exchange duty, became a POW. No RF-8s were lost to North Vietnamese fighters. All 20 VFP-63 and 12 VMCJ-1 combat losses were from flak and SAMs.

Bellinger gets a MiG

The VF-162 loss to MiGs involved the squadron's colourful skipper, Commander Dick Bellinger. At 42, Bellinger was a little older than the average fighter skipper, but he had flown in World War II as a USAAF bomber pilot, transferred to the Navy after the war and flown combat in Korea. In his third war – Vietnam – Bellinger knew this was probably his last chance.

A VF-53 F-8J enters the landing pattern for* Bon Homme Richard *during the old ship's last and relatively uneventful combat cruise in 1970. Commander Guy Cane had accounted for the squadron's only MiG kill in 1968, flying from the same ship. 'Bonnie Dick's' Crusader squadrons had scored 11 of the 18 confirmed F-8 kills.

After a high-speed chase over downtown Hanoi, with one 'Hunter' pilot dragging a MiG that had locked onto his tail, Lieutenant Commander Chuck Tinker only succeeded in evading his pursuer by dodging buildings at 50 ft (15 m) above the densely populated city. Tinker did not have a working radio – the flight had known this prior to going over the coast – and when he saw yet another MiG on his CO's tail, he could not warn him. After the MiG peppered his Crusader, Bellinger ducked into a cloud and limped away, trying to make Da Nang before his fuel ran out. He was unable to refuel from an orbiting tanker because of the damage to his aircraft, and he ejected from his crippled Crusader 40 miles (64 km) from the mainland.

On 9 October Bellinger led three other 'Hunter' Crusaders acting as escort for an A-4 strike from the carrier *Intrepid*. An E-1 Tracer vectored the escorts toward incoming MiGs, which turned out to be MiG-21s; this type only recently had entered service with the North Vietnamese air force and represented a considerable jump in technology for the beleaguered Communist air service.

One of the delta-winged MiGs split-essed toward the ground, and Bellinger followed, firing two Sidewinders. He was at a dangerously low altitude and could not watch the progress of his missiles as he zoomed over the jungles. One of the Sidewinders found its mark and the MiG-21 crashed into the rice paddies below, marking the first Navy kill of the advanced MiG. Dick Bellinger flew back to *Oriskany* to a tumultuous welcome from his ship and squadron. One week later, Secretary of Defense Robert McNamara, on a Vietnam tour, visited *Oriskany* to personally award Bellinger the customary Silver Star for his MiG kill.

F-8s did not score again until May 1967, by which time the American bombing offensive against the North Vietnamese was in full swing. Daily strikes seemed to be hurting the North's ability to continue the war, even with major restrictions levied by Washington as to what type of targets could be hit, and where and when. Even with the high number of losses, and the uncertainty about the fate of the US crews after they bailed out, the Americans hurled themselves at their objectives.

May 1967 was an especially hectic period, and all squadrons from all ships on the line participated in a number of large raids. The MiGs were active during this time, and the engagements were sharp and intense. *Bon Homme Richard*'s Air Wing 21 was in the forefront of Navy successes, beginning on 1 May, the traditional Communist holiday. Lieutenant Commander M. O. 'Moe' Wright of VF-211 shot down one of three MiG-17s while he was escorting Iron Hand A-4s 35 miles (56 km) north of Hanoi. He got on the MiG's tail as it attacked an A-4 and fired a Sidewinder, which sent the MiG tumbling into the ground.

Air Force Captain Ron Lord, serving an exchange tour with the 'Checkmates', flew with Wright. "It was a beautiful hit," Lord said later. "The MiG just came apart at the seams." Later, Lord chased a MiG off another A-4 with his cannon. Wright was closing on another MiG, and might have had a chance at a second kill in a few seconds. However, he decided that his primary responsibility was

protecting the A-4s, and he left the MiG to rejoin the strike group.

In addition to Wright's kill, Lieutenant Commander T. R. Swartz got his A-4C behind a MiG. The VA-76 pilot fired three separate Zunis – normally ground-attack weapons – at the MiG, which also dived into the ground. Ted Swartz was actually a Crusader alumnus, having gained 2,000 hours in the F-8. He was an instructor and LSO (landing signal officer) for VF-174, the East Coast F-8 training squadron. While at Cecil Field, Swartz instructed many of the Crusader pilots who ultimately fought in Vietnam. When his tour was about to end, however, Swartz was convinced the Vietnam War would be an attack pilot's war, and he asked to be sent to an A-4 squadron. But he remained a fighter pilot, and when the opportunity came he took it, becoming the only A-4 pilot to score a MiG kill in Vietnam.

The F-8's best days came next, 19 May and 21 July, when eight pilots shot down eight MiGs, accounting for nearly half of the entire Crusader tally in the war. The mission for 19 May involved A-4/F-8 Iron Hand strikes against heavy concentrations of SAM and flak position, complicated by heavy MiG opposition. The strike force encountered intense 37-mm, 57-mm and 85-mm fire. VF-211 and VF-24 provided the escort. One F-8E from VF-211, BuNo. 150930, was brought down by a SAM, its pilot captured. Five other F-8s were damaged by flak and MiG cannon fire.

In the aerial engagements, the two 'Bonnie Dick' squadrons scored two MiG-17s apiece. VF-24's Lieutenant Commander (later Rear Admiral) Bobby Lee and Lieutenant (later Captain) Phillip Wood, in F-8Cs, and VF-211's skipper, Commander (later Rear Admiral) Paul Speer, and Lieutenant (jg) Joseph Shea, each fired Sidewinders. Lee's and Wood's kills were the first for their squadron.

Tough cruise

It had been a hard cruise: CVW-21 lost 23 aircraft and 18 pilots. On 19 May Lee was Wood's section leader as they escorted A-4s on a strike against Hanoi. Nearing the target, they spotted a MiG-17 closing on an A-6 from the *Kitty Hawk*, which was also on the raid. In a tight turn, Lieutenant Wood fired a Sidewinder but the missile fell off harmlessly because of the *g*s. The MiG pilot dove for safety. Another MiG-17 came in behind Wood and began firing. He hauled his F-8 around and fired another AIM-9D; this missile hit the MiG and sent it diving toward the ground. The enemy pilot ejected, but his chute streamed. Unable to get back to his carrier, shot up and low on fuel, Lieutenant Wood took an interval in the *Kitty Hawk*'s landing pattern and trapped on the big-decked carrier. He was warmly greeted by the crew of the A-6, whose tail he had cleared of the first MiG. His F-8 was a strike, and Wood took advantage of a helo ride back to his own carrier, where the festivities were already in progress over the latest MiG kills.

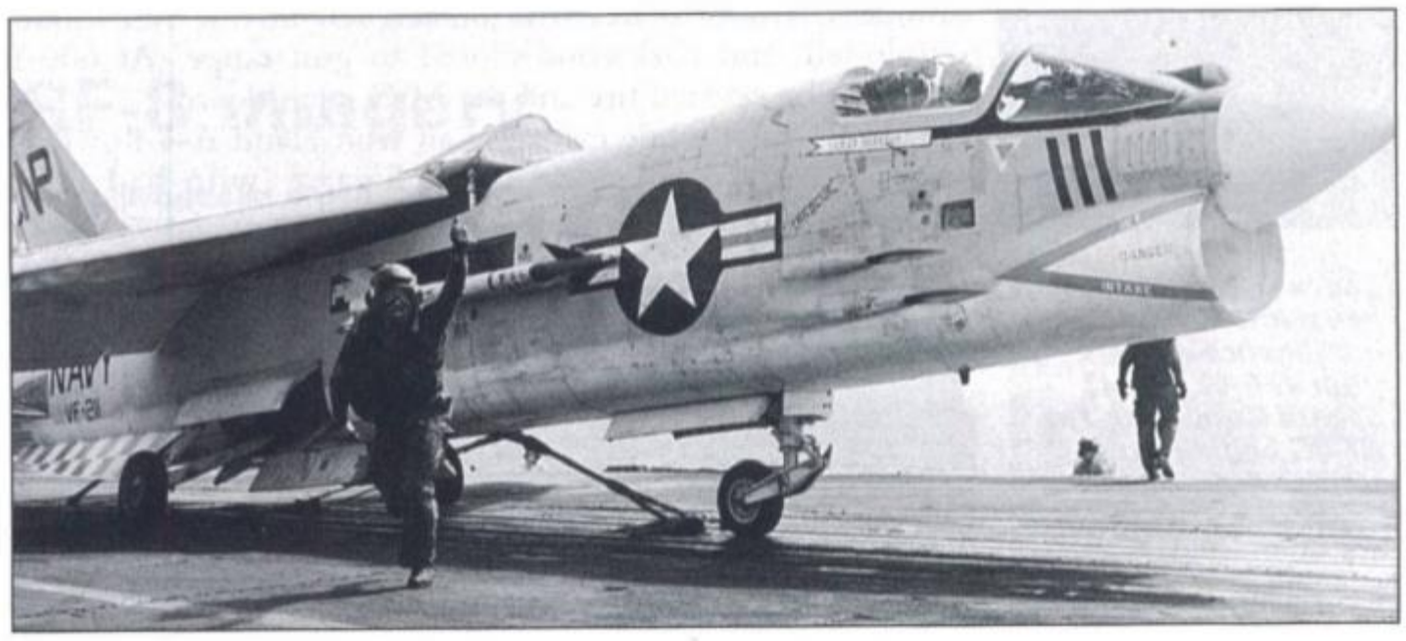
Lieutenant Commander Bobby Lee had taken his wingman, Lieutenant (jg) Kit Smith, to go after the SAM sites. At 3,000 ft (914 m) they fired their Zunis, hitting the SAM's radar vans. As the two F-8 pilots pulled out of their runs at 700 ft (213 m), a MiG-17 crossed their noses. Lee fired a Sidewinder, which cut the MiG in half.

Two months later, on 21 July, four Air Wing 21 pilots scored. While proceeding to their target, a POL storage facility near Haiphong, CVW-21 A-4s were attacked by an estimated force of 10 MiG-17s. The combined VF-24 and VF-211 escort waded into the interceptors. VF-24's newly arrived executive officer, Commander Marion H. Isaacks, got above and behind one MiG. He tried twice to fire his Sidewinders – he was carrying a full load of four – but the first AIM-9 failed to guide, and the second malfunctioned and did not fire. Frustrated, he tried once more. This time the third missile came off the rail and tracked perfectly, right up the MiG's tailpipe. The enemy fighter went down in a fireball.

Staring at the fireball, Isaacks nearly became someone's kill himself when one of the MiG's wingmen drove in, firing all the way. Isaacks kicked right rudder, turning to meet his attacker. With his windscreen full of MiG intake, the VF-24 XO gaped as the North Vietnamese pilot turned away at the last moment and snap-rolled for the deck, leaving Isaacks with a badly damaged Crusader. His F-8 had a small fire near the right aileron, fed by hydraulic fluid. However, the blaze remained confined to the small area on the wing, and after the fluid had been consumed the fire extinguished itself as Isaacks flew back to the carrier.

Isaacks summed up the air war during a visit to LTV soon after his MiG kill. "The MiGs are good for morale, I guess. There's more glamour in shooting down a MiG than shooting up a SAM site." But, he added, missile and gun emplacements caused more concern for pilots than MiGs in the air.

VF-191 and VF-194 (illustrated) manned the last active-duty cruise for the Crusader, sailing aboard* Oriskany *in September 1975 for the WestPac area. The cruise was dogged by frustrations, and returned early, arriving back in San Francisco in March 1976, so ending the fighter Crusader's career at sea.



While VF-191 and VF-194 continued cruising with* Oriskany, *VF-24 and VF-211 served aboard* Hancock *into the last months of the Vietnam War. Here a VF-211 F-8J prepares to launch for a mission during the hectic fighting in 1972.

Left: Partnering VF-194 on the fighter Crusader's last cruise was VF-191, two of the latter's F-8Js being seen here in late 1975. It was also the last cruise for a '27-Charlie' carrier, in this case* Oriskany, *as the small decks could not accommodate the F-4 Phantom or A-6 Intruder.

Above: Seconds away from launch, a VFP-63 awaits the cat stroke from* Bon Homme Richard. *The photo-birds performed valiantly throughout the entire war period, flying from both large and small carriers.

Right: Atlantic Fleet photo-reconnaissance squadron VFP-62 made only one cruise in Southeast Asia. The unit's Det 42 flew from* Franklin D. Roosevelt *during 1966/67 as part of Air Wing One.

Above: These are the five pilots and two intelligence officers from VFP-63 Det. 43 aboard* Coral Sea. *The RF-8G behind carries the ECM fairing on the leading edge of the fin.

A pair of VFP-63 RF-8Gs overflies the* Hancock *during a pre-cruise work-up. The photo-birds were employed on both high- and low-level reconnaissance missions, using the aircraft's blistering speed as the principal means of defence against SAMs and AAA. Against MiGs, however, the RF-8s required fighter escort.

Lieutenant Phil Dempewolf also scored a probable with a Sidewinder. Positive confirmation could not be made because two other MiGs attacked after Dempewolf's MiG went down.

Lieutenant Commander Robert Kirkwood became one of two Crusader pilots who could claim a much-desired 'guns only' kill, firing his 20-mm cannon at a MiG-17. Lieutenant Commander Kirkwood was the leader of the second section flying TARCAP for 15 A-4s. He had fired a Sidewinder at Isaack's MiG, but the XO's missile got there first. Kirkwood manoeuvred behind another MiG and fired another AIM-9. The MiG turned left as the Sidewinder exploded, and Kirkwood closed to gun range. At 600 ft (183 m) he opened fire and the MiG went down.

On 21 July, while escorting an Iron Hand A-4 flown by Lieutenant Commander T. R. Swartz (who had got a MiG-17 with Zunis on 1 May), Lieutenant Commander Tim Hubbard of VF-211 used his only Sidewinder and two Zunis as well as 20-mm cannon-fire to down another MiG-17. This kill brought VF-211's total to seven, making it the highest-scoring Navy squadron at the time and, ultimately, the most successful Crusader squadron.

CVW-21 was now the highest scoring air wing. Only in 1972 did *Constellation*'s Air Wing 9 tie the *Bon Homme Richard*'s record with nine kills from January to May, including the four MiG-17s and one MiG-21 attributed to the Navy's only aces, Cunningham and Driscoll of VF-96. The Air Wing 21 cruise report – part of the massive amount of paperwork required by every combat deployment – attributed the wing's success against the MiGs to using the F-8s in their designed role: fighters.

"One radical deviation made by this air wing in contrast to others was the employment of F-8 aircraft. The F-8s were used primarily as fighters. Wing bomb racks were never installed. As a result, nine MiG-17s were confirmed shot down, plus one probable and nine more damaged in the air. When air-to-ground ordnance was desired, Zunis were used . . . which mount on the Sidewinder missile stations. In certain cases, six Zunis and one AIM-9D were carried. F-8s in this configuration had two confirmed MiGs."

All the CVW-21 F-8 MiG-killers received the traditional Silver Star for their achievements. Lieutenant Dempewolf received the lesser Distinguished Flying Cross for his probable. Commander Speer also received the second Navy Cross awarded to a VF-211 pilot. The Navy's highest award was given for his having "contributed greatly to the successful execution of this mission" by protecting the A-4s from the determined enemy attack.

The Crusader had established its credentials as a MiG-killer, and was eventually tagged by zealous public relations officials as 'the MiG-Master', but time was growing short. The final US Navy MiG kill for 1967 was registered by a VF-162 F-8E. Lieutenant Richard Wyman launched on 14 December as a spare. Three other Crusaders had been scrubbed for mechanical reasons, and Wyman and Commander Cal Swanson, who had assumed command of the 'Hunters' a year before, headed inland. Swanson's radar was down, and the lead fell to the junior pilot.

The pair spotted an A-4 with a VF-111 F-8 escort. The A-4 pilot, Lieutenant (jg) Chuck Nelson, told them there were MiGs nearby. The F-8s quickly closed on the fight. The MiGs were all over the lone 'Sundowner' F-8C, flown by Lieutenant Commander (later Captain) Dick Schaffert, who constantly outmanoeuvred the aggressive North Vietnamese fighters. Finally, the 'Hunter' flight got within range and Swanson tried to manoeuvre with one of the

Flying Squirl *was an RF-8G from VFP-63's Det 19 aboard USS* **Hancock** *for the 1971 cruise. It has adopted the checkerboard markings and stylised 'tick' from the carrier's fighter units. The escorting VF-24 F-8J serves to illustrate the considerable differences to the forward fuselage between the fighter and the photo versions.*

MiGs, but the North Vietnamese pilot got on his tail. Wyman shot a few bullets toward the MiG in an effort to save his skipper. Apparently, the MiG got the message and broke off.

Another Crusader pilot, Commander Bob Rasmussen, CO of VF-111, fired a Sidewinder, but missed. The fight was now down to the trees; it had started at 16,000 ft (4877 m). Wyman positioned himself behind the MiG and fired another Sidewinder. This time, the AIM-9 guided perfectly and took off the MiG's left wing. The enemy fighter dove into the ground only 50 ft (15 m) below. The fight had shown there were good pilots on the other side, too. It had taken four F-8s, twisting and diving all over the sky, to bring down one MiG. Wyman recalled the climax of the long fight. "The wing fell off. Red fire streaked along the left side of the aircraft as it cartwheeled into a rice paddy." Cal Swanson commented, "That was probably the longest MiG engagement of the war. That MiG pilot was a tiger. He was there to fight."

The last MiGs, 1968

MiGs were scarce for the next six months, at least for the Navy. The next kill did not come until June 1968 and, again, the victor was an F-8. Commander (later Rear Admiral) L. R. Myers, skipper of VF-51, on his 182nd mission over Vietnam, used a Sidewinder to blow the tail off a MiG-21 on 26 June. The MiG made a head-on pass against the three VF-51 fighters. Myers wrapped his Crusader into a turn, which put him at the MiG's six o'clock, and he fired his Sidewinder. It was the first of two kills for the F-8H model of the Crusader.

John Nichols got the next kill, giving a good illustration of why no RF-8s were brought down by MiGs. On 9 July Nichols escorted an RF-8 on a low-level photo mission south of Vinh. The two *Ticonderoga* Crusaders launched for the afternoon mission and ran in toward the target, drawing anti-aircraft fire all the way.

Lieutenant William Kocar brought his RF-8 down to 2,000 ft (610 m), while Nichols remained at 3,000 ft (914 m). As Kocar made his runs, Nichols spotted a camouflaged MiG-17 streaking toward the photo aircraft. Shouting a warning to the photo pilot and the 'Tico' controllers, Nichols followed the RF-8 into a hard turn, just as tracers streamed past him. He had not seen the first MiG's wingman.

Nichols focused on the lead MiG and fired a Sidewinder, but he was too high and the missile could not guide properly. The MiG pilot suddenly stopped his turn, rolled wings level and lit his afterburner. Nichols closed in and fired a second Sidewinder. This time the missile hit the MiG, causing major damage. The fighter remained in the air, to Nichols' amazement, and he began firing his cannon, obtaining a few hits. The MiG was mortally wounded, and eventually disintegrated. Lieutenant Kocar in the RF-8 excitedly confirmed the kill.

After the Crusaders recovered, the intelligence depart-

A VFP-63 RF-8G launches from* Oriskany *during Yankee Station operations in September 1967. Most of the unit's RF-8s wore the 'Eyes of the Fleet' markings on the raised wing bulkhead.

Below left: This high-altitude image depicts an SA-2 missile site.

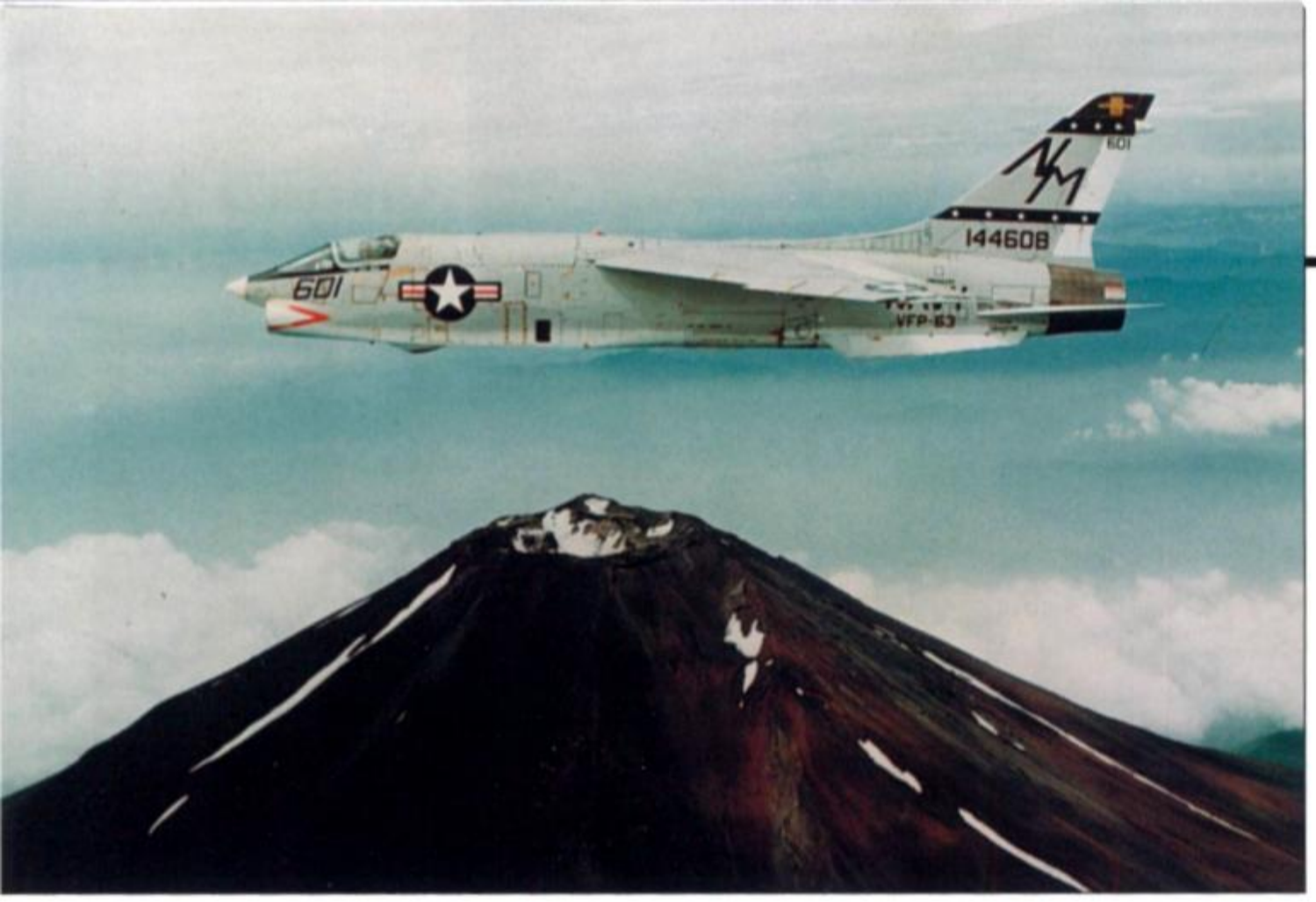
Below: A panoramic image captures the RF-8's shadow passing over a burning Viet Cong patrol boat after a 1965 attack by* Midway *aircraft.

ment presented Nichols with a biography of the young North Vietnamese pilot of the downed MiG. He had only about 450 hours total time, with 250 hours in the MiG-17. "Not a great deal, but it should have been enough to hack the programme with his initial advantage," Nichols later wrote.

On 27 July Commander Guy Cane, executive officer of VF-53, leading four F-8Es, encountered four MiG-17s and shot one down with a Sidewinder. Meeting a two-aircraft section head-on, Cane and his wingman, Lieutenant (jg) Dexter Manlove, ended up turning with the enemy fighters until Cane got off one missile, which detonated just behind

RF-8 imagery

RF-8s produced a wide range of imagery during the war. For high-level work the big vertical cameras were favoured, while at low level a panoramic camera (replacing the original trimetrogon installation) or forward oblique was used. The latter provided useful ingress images for plotting attack runs.



***Above: In 1958, Marine Major John Glenn used this aircraft (then an RF-8A) for the Project Bullet transcontinental speed record. In December 1972, the aircraft (now an RF-8G) was lost in a ramp strike in the South China Sea, the pilot ejecting successfully. Here it is seen during its ultimately fatal deployment aboard* Oriskany.**

Right: Marine photo squadron VMCJ-1 operated the RF-8A intensively in support of combat operations during the early years of the Vietnam War. In addition to the shore-based operations, the squadron occasionally sent detachments aboard carriers to augment the hard-pressed VFP-63.

Shore-based KC-130s were occasionally used to refuel RF-8s, although the photo-birds rarely required tanking. The swelling of the RF-8's forward fuselage allowed the probe to be accommodated within the aircraft's contours, rather than in a bulge as on the fighter versions.

the MiG's tailpipe. "I thought it had missed until a chunk of his starboard wing came off and the MiG went into a nose-down spiral," Cane said. It was his 186th combat mission, and his first encounter with a MiG.

The Crusader's next kill followed only three days later, on 1 August. Again, it was a photo-escort mission, or at least that is how it started. Lieutenant Norm McCoy of VF-51 was in an F-8H, paired with Lieutenant Jay Miller in an RF-8G from VFP-63's Det 31 (the det number referred to the carrier number). Miller, on his second combat tour, had returned from his 1967 *Coral Sea* cruise and had been assigned as the communications officer for VFP-63. The interminable paperwork got to him, and he told his OINC (officer in charge) to send him out again to fill a hole in the 'Bonnie Dick's' photo detachment created when another RF-8 pilot had been shot down. At first, the OINC, Lieutenant Commander John 'Dutch' Schulze, denied the request, but soon told Miller to pack his bags.

Joining his detachment on board the *Bon Homme Richard*, Miller began his second combat tour. At the time of McCoy's kill, the F-8s had lost several aircraft and did not always have enough for all the missions. Miller's account of Norm McCoy's MiG kill on 1 August follows.

"McCoy joined up with George Hise, who was by himself. They got a vector toward a MiG from 'Red Crown' – the ship that functioned as a radar picket and kept a watch for MiGs. Hise made contact and fired a missile. He called a hit. Within seconds the MiG went into a cloud, and the F-8s lost sight of him.

"When they re-acquired him, McCoy was in the driver's seat, close to a minute after Hise's call. He pickled off a 'winder and nailed him. Bang! right there. Then, someone asked his [fuel] state, and he came up with something ridiculous, 1,400 or 1,600 lb. They gave him a tanker call, and he refused. He later told me he was following the MiG down taking pictures with his Super 8 movie camera mounted on his glare shield. He chased the MiG to the impact and got pictures of the smoke and flames. I think the MiG pilot ejected, but I'm not sure. When McCoy crossed the beach, he had about 800 lb of fuel.

"When we got back to the ship, the CAG listened to the tape of the kill I'd made in the aircraft and determined that since the MiG was still flying a full minute after Hise's hit – which apparently knocked off a piece of the MiG's wing – it was still manoeuvrable until McCoy's hit, which was fatal. He got the kill. But they went to Saigon for the usual MACV briefings that followed a kill."

The final kill

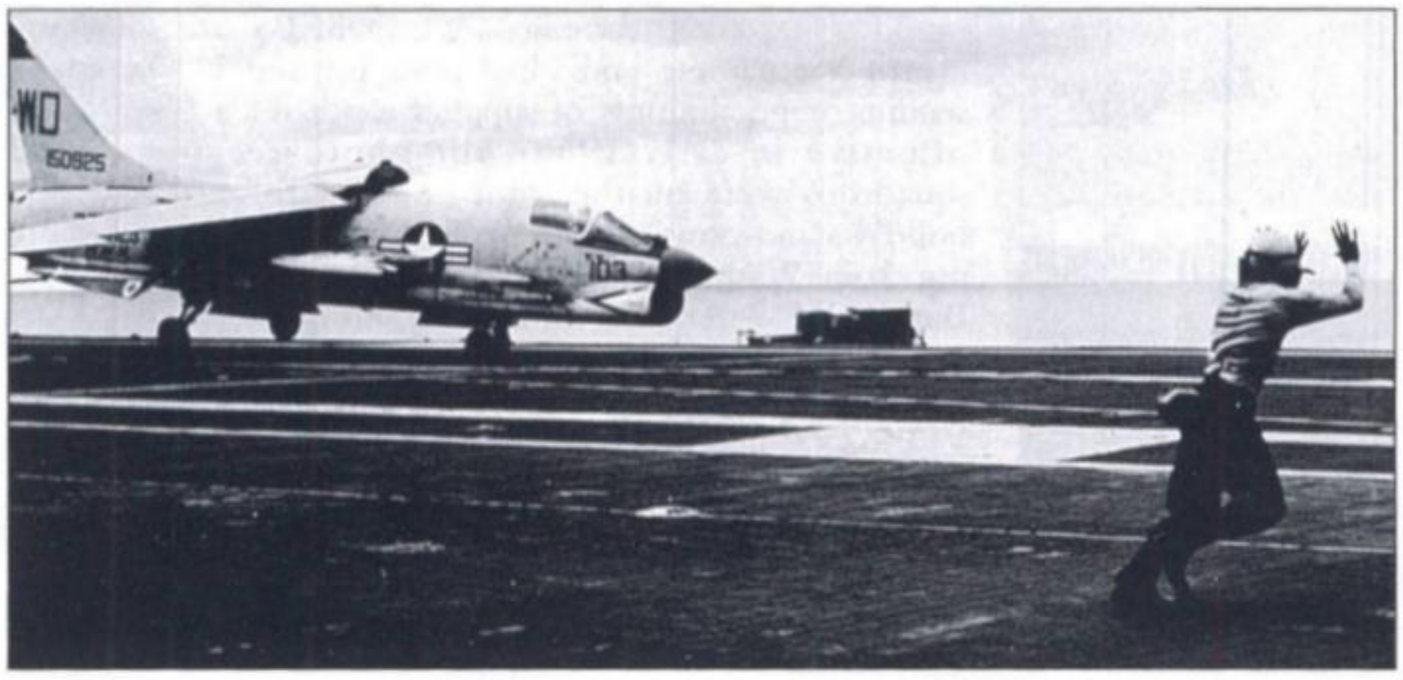
The Crusader's last kill went to Lieutenant Anthony J. Nargi of VF-111's Det 11, operating from the veteran '27 Charlie' carrier *Intrepid*. The old ship, which had suffered a major kamikaze strike at the end of World War II in 1945 and was finishing its days as an anti-submarine carrier (CVS), had been drafted to serve as a modified attack carrier with a small attack air wing, using A-4s and a detachment of 'Sundowner' F-8Cs.

Nargi and his wingman, Lieutenant (jg) Alex Rucker, were on a CAP mission on 19 September when they were alerted to incoming MiGs, headed for their A-4 strike force. The two F-8s climbed to meet the threat, which turned out to be MiG-21s. "I think the MiG pilot saw me about the same time," Nargi reported. "I called 'MiG-21 high' to my wingman. The MiG pilot started taking evasive manoeuvres immediately. He climbed and went into a loop, and I was able to get into position behind him." Nargi fired a Sidewinder, which blew the MiG's tail off, and the enemy fighter went down in a fireball. The North Vietnamese pilot ejected and floated down under an orange-and-white parachute.

Nargi and Rucker engaged a second MiG. Both F-8 pilots fired missiles, which exploded close to the MiG, but the enemy aircraft seemed undamaged and quickly headed north to escape the VF-111 fighters. It was the Navy's 29th MiG kill of the war, and the F-8's 18th confirmed score.

Marines at sea

While most of the Marine operations were shore-based at Da Nang, the F-8Es of VMF(AW)-212 undertook one carrier cruise. This lasted from April to December 1965, the F-8s flying as part of Air Wing Sixteen aboard Oriskany. The Marine unit largely flew attack missions, while Navy partner squadron VF-162 provided fighter cover. One 'Lancers' aircraft was shot down, the pilot being captured.



When all the numbers were tallied, the Crusader racked up a 6:1 kill-loss ratio, for the loss of three F-8s. Oddly enough, Navy F-4s gained 36 kills for the loss of six Phantoms, creating the same ratio of 6:1.

Pickings were lean for the next three years, with only one Navy F-4 crew scoring in 1970. It was not until the heavy combat in the spring of 1972 that all US crews began to score again. Carrier-based Phantoms shot down 26 MiGs from 1970 to 1973; they had scored 10 times during 1965-68. For the F-8, however, Nargi's kill represented the end to a relatively short, but intense, list of victories. But that did not mean the Crusader's war was over.

The photo birds

The reader can appreciate the active role the RF-8 detachments played throughout Vietnam. While their more glamorous fighter pilot compatriots shot the guns, dropped the bombs and downed the MiGs, the men of the light-photo dets fought their own dramatic and highly dangerous war. "Unarmed and unafraid" was the reconnaissance pilot's motto. Jay Miller said, "Well, I sure was unarmed, but I don't know about the second part."

VFP-63 lost 20 RF-8s to the deadly North Vietnamese flak and SAMs, although not one photo-bird was downed by a MiG; testimony, in part, to the teamwork between the photo pilots and their fighter escorts, as well as the intensive training and planning conducted by the crews. Light-photo – indeed, all photo-reconnaissance – was a dangerous proposition. Other squadrons in other carriers flying the more sophisticated RA-5C Vigilante and special reconnaissance versions of the big A-3 Skywarrior also suffered many losses, out of proportion to the size of individual detachments and the overall number of the specific type of aircraft eventually produced. RF-8 pilots were among the most highly decorated of all military fliers, and the most skilled in a speciality requiring mastery of a demanding aircraft, an occasionally temperamental and complicated camera system, and, not least, a large helping of intestinal fortitude.

The PIs

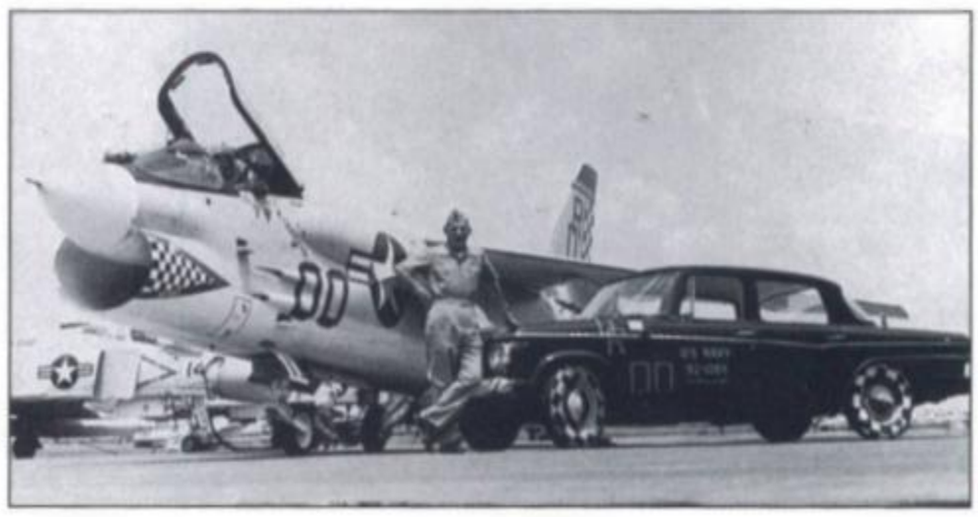
One unusual aspect of the RF-8's mission was the close relationship between the pilots and their ground team, especially the small group of specialists who looked at the mission film. In addition to the complement of pilots and normal maintenance and administrative personnel, each detachment included four or five specially trained individuals. These enlisted men and officers planned, briefed, debriefed and reported the flights of their RF-8 pilots, exhibiting a close involvement with the overall mission not found in other squadrons.

The enlisted men were Photographic Intelligence Mates (PTs), while the junior officers who accompanied the detachment in the intelligence departments were designated Photographic Interpreters (PIs). These intelligence specialists were a vital part of the overall mission, and they assumed responsibilities out of proportion to their relatively junior years.

Lieutenant (later Captain) Louis R. Mortimer was a PI and worked through an intense period of combat operations, learning his job and working with the many individuals in his detachment, and in the air wing. He went through the turmoil of losing his OINC shortly after *Coral Sea* arrived on the line.

"Lieutenant Commander Jim Vescelius became our OINC. Originally, he was going to be the second in command, because he was junior. Lieutenant Commander Ron Sonniksen was supposed to be our OINC. But there was a problem with the OINC of another detachment in the *Oriskany*, and they sent Sonniksen to the *Oriskany*, and Vescelius took over as the senior guy.

"All the other air wing pilots were debriefed by the ship's AIs, but in VFP-63 we debriefed our own pilots. Debriefing was a tough act because some pilots looked down on the poor AI trying to get information from the pilots who had been on the mission while he was safe on the ship. But, there were only a few of those types.



Above left: A deck crewman signifies a successful trap to the pilot of this VMF(AW)-212 F-8E as it lands aboard* Oriskany *in 1965. It was to be another seven years before Marine fighters went to sea on a combat cruise (VMFA-333 F-4Js in USS* America*).

Above: Red-shirted ordnancemen prepare Zuni rockets for the Crusaders of VMF(AW)-212 in 1965.

Left: Colonel R. F. Conley, commander of MAG-11, stands beside his appropriately decorated Studebaker and an F-8E of VMF-312 in 1964 at Atsugi. After demanding permission to go into combat, '312 went to South Vietnam for a few months but was not to return to the war zone.

Below: Armed with bombs fitted with 'daisy-cutter' fuse extenders, a VMF(AW)-235 F-8E takes off from Da Nang. The 'Death Angels' alternated with VMF(AWA)-232 in manning the Crusader deployment in Vietnam.

Above: Operating on daily ground attack missions, the Marine F-8s rapidly became very dirty, especially from the repeated use of the 20-mm cannon. This aircraft carries 5-in Zunis on the Y-racks and 'slick' Mk 82s from the wing pylon-mounted MER (multiple ejector rack).

Right: Although there was not a fighter pilot in the war who did not dream of getting a MiG, the Marine F-8 pilots at Da Nang had to put such thoughts to the back of their minds. Most of the missions were short-range close-support sorties helping troops in contact. Marine F-8s were especially active during the hectic fighting for Khe Sanh.

Rocket fighter: in addition to the full load of 5-in Zunis, this F-8E seen leaving Da Nang in April 1967 carries a 19-round rocket launcher for 2.75-in weapons on the wing pylons.

"Our photo pilots were always anxious to talk to us, however, because they understood the need for the information to look at their film. Photo pilots were more sophisticated than other wing pilots, because the photo pilot was the flight leader, even though he might be junior – way junior – in rank to his escort. Even if the escort pilot was the skipper of the fighter squadron, the jaygee in the RF-8 was the flight lead. Sometimes it caused friction.

"We read the mission film for BDA (bomb damage assessment) after a strike to see if another strike was needed. The air wing would hit a target, closely followed by our photo-bird. That was something we told them not to do, because the Vietnamese knew that the unarmed photo bird would come along, fly straight and level, and they could blow him away. But they did it that way. That's how our OINC, Lieutenant Commander Vescelius, got bagged on 21 September 1967 during a strike over Haiphong. We needed immediate BDA, right after the bombs, showing the bursts, and he flew way too low in an effort to get really good coverage. He broke the 3,500-ft minimums."

Unfortunately, with all the heroic and dedicated efforts of the men and ships of TF 77, the Communists were in no mood to talk, and the war continued. By late 1967 the North Vietnamese embarked on a big supply operation, sending huge amounts of supplies south for a big military offensive in early 1968. The photo-reconnaissance squadrons were on the front lines for this one. With a holiday stand-down and peace bargaining schemes emanating from Washington, most of the intense strikes ceased. But the RF-8 dets flew on and on, and on.

A major development in the RF-8 community was the decommissioning of VFP-62 on 5 January 1968. Although VFP-62's usual duties kept it with the Atlantic Fleet, one detachment had made a Pacific combat deployment in USS *Franklin D. Roosevelt* (CVA-42) as part of CVW-1. VFP-62 Det 42's cruise from June 1966 to February 1967 brought the combat loss of at least one RF-8G. Of course, the 'Fightin' Photos' finest hour was in October 1962 during the Cuban Missile Crisis. After more than 100 detachments in 22 carriers, in 19 years of service, VFP-62 was retired.

This change seemed to affect the entire reconnaissance community, as other squadrons were decommissioned, including VAP-62 on 15 October 1969 and its sister squadron VAP-61 on 1 July 1971. These squadrons had given yeoman service in Vietnam with their RA-3Bs.

With the demise of VFP-62, VFP-63 now assumed all responsibility for providing RF-8 dets to all the Navy's carriers worldwide, but the emphasis remained in Vietnam. In 1971, the squadron was restructured to include a permanent shore command – the 'home squadron' – and five numbered detachments, with two dets for Atlantic operations and three for the Pacific Fleet.

Crusader training

On 1 September 1972 VFP-63 also assumed responsibility for all F-8 training in the Navy. VF-124, long known as 'Crusader College', began to gear up for the F-14 Tomcat which was then in the early stages of flight testing. VFP-63 had received F-8Hs in 1969, the idea being to provide RF-8s with their own escorts. However, the requirements in the fleet necessitated redistributing the F-8Hs to fighter squadrons, and VFP-63 had to wait until the mid-1970s to get fighters once more. By that time, the F-8 had left the fleet, and the fighters served as squadron hacks and currency trainers.

The RF-8A eventually gave way to the updated RF-8G, the first of which had initially been modified from existing As in 1963. The RF-8G joined the fleet in October 1965, and made its first cruise beginning in July 1966 on board the *Coral Sea*. The RF-8G was immediately distinguishable from the A model by the long ventral strakes mounted on the rear fuselage. These were supposed to give greater stability, but pilots seldom detected any difference between the two models. The strakes had actually been introduced on the F8U-2 (F-8C). The RF-8G featured many internal modifications, including an uprated engine (the 16,000-lb/71.17-kN Pratt & Whitney J57-P-22), hard-harness electrical wiring and various avionics updates. The RF-8A's cameras were also changed in the G, and better ECM gear was installed.

VMF(AW)-232 took over the Marine detachment from '235 in late 1966. This pair of F-8Es is seen with widely differing bombloads: the right-hand aircraft has Mk 82s with Snakeye retarding fins, while the other has WWII-era box-finned bombs.

Vought F-8E VMF(AW)-235 Da Nang, 1968

Marine losses
During the Vietnam War the Marines lost 12 F-8Es to flak, two to enemy ground attacks against Da Nang and nine in operational accidents (including one RF-8A).

Visibility
Forward visibility was considered excellent, although the pilot had no airframe points of reference other than the IRST turret.

Bomb drop
The Marines developed several methods of bomb release, the most interesting being a split-S profile from 20,000 ft, dropping the bombs in a 90° dive at about 10,000 ft. To drop two Mk 84s the pilot had to use the normal pickle button in conjunction with the jettison command.

Bomb options
The F-8E was notable for being the only fighter aircraft in Vietnam able to carry the 2,000-lb (907-kg) Mk 84 bomb, and this weapon was regularly used, carried directly from the wing pylon. For smaller weapons multiple ejector racks were used, a slant four configuration being adopted on each rack. Mk 82 500-lb (227-kg) weapons with either slick or Snakeye tails figured prominently.

This F-8E was flown by Major Colin Ruthven during 1967/68, and is depicted as it would have appeared during the siege of Khe Sanh. The bright red star-studded markings gave rise to the 'Bozo Noses' nickname for VMF(AW)-235.

Zuni rockets
The 5-in (127-mm) Zuni rocket was the most widely used of the F-8's attack weapons. The aircraft could not carry the standard four-round LAU-10 launcher on the fuselage pylons, and so specialised two-round launchers were developed. The rockets had various warheads in the 43- to 56-lb (19.5- to 25.5-kg) class, including HE frag, general purpose, anti-personnel, incendiary, smoke and flare.

Radar
The F-8E introduced the AN/APQ-94 radar. This had a larger-diameter dish than the D's APQ-83, resulting in a corresponding bulge to the radome. Another E feature was the SEAM (Sidewinder Expanded Acquisition Mode).

VMF(AW)-235
The 'Death Angels' rapidly became one of the best-known units flying in Vietnam. They were once described by a former squadron member as "the wildest bunch of crazies I've ever had the pleasure to serve with . . . kicked out of every O-Club in the Orient, but how they could fly the F-8!" The squadron's two deployments ran from February to November 1966 and from May 1967 to the end of 1968. The unit flew 9,140 operational missions.

Rocket attack
The Zuni was a very accurate weapon, but required precise aiming. At 1,500 ft (457 m) range the Zuni and cannon were boresighted, so the method was to walk 20-mm cannonfire on to the target before firing the Zuni at the correct range, taking care to evade the rocket's frag pattern.

Above: The bicentennial anniversary in 1976 allowed US military units a relatively free hand to adorn their aircraft with colourful patriotic markings. These RF-8Gs wear VFP-63's contribution to the festivities.

Above right: For most of the 1960s VFP-62 provided the photo-reconnaissance detachments to Atlantic Fleet carriers, an RF-8A being illustrated here launching from USS Enterprise. The squadron was decommissioned on 5 January 1968, leaving VFP-63 to provide all active-duty RF-8 assets.

VFP-63 continued to provide recon dets long past its planned 'sell-by' date. With continual modifications, the RF-8G remained a viable reconnaissance platform to the end of the 1980s, and many argued that with an infra-red sensor it would have been far more suitable to the role than the TARPS-equipped Tomcat which replaced it.

The interim period of reduced activity came to a dramatic end on Easter weekend 1972 as hordes of North Vietnamese troops and VC guerrillas poured across the South Vietnam border, catching the South Vietnamese by surprise. Divested of much of the American protection they had enjoyed in the first part of the war, the Republic of Vietnam's troops reeled backward from the onslaught. Finally, they gathered themselves together and halted the enemy advance, at least enough to allow American units to return.

While the carrier task forces had been reduced, those that remained on station in the South China Sea had not been idle and had supported several operations. By late 1971 the pace had begun to increase, and following the Easter invasion the United States scrambled to reinforce the small number of squadrons and personnel still in South Vietnam, or off the coast. By July there were six carriers on the line. For many aviators who had served earlier cruises in the 1960s, nothing had really changed.

Will Gray had served in VFP-63's Det 43 during *Coral Sea*'s busy 1967-68 cruise. He had remained in F-8 squadrons in the US, but eventually returned to light-photo, flying from *Midway* during 1972. "The war was just the same as it had been in 1967. If I had saved my maps I cold have used them all over again. There were three carriers in the Gulf of Tonkin that had RF-8 dets, so I had to use a new callsign for my det. Instead of the familiar CORKTIP, we were now BABY GIANT. And our familiar Papa Papa ('PP') tailcode letters were replaced with November Foxtrot ('NF').

"The North Vietnamese defences were virtually the same except for one encounter I had with a ZSU-23. I was running a section of railroad that crossed the Thanh Hoa Bridge. I approached the bridge from the north at about 600 kt and 4,500 ft. I had my eyes on the viewfinder, following the rail line. I looked up to see a stream of red coming right at me from a point on the ground right by the railroad. It looked like a solid red line. I just about broke my right leg getting in rudder to break away. They missed! It was over in a second, but I was impressed. It took me a couple of miles to get back on the route and continue south until my Phantom escort ran low on fuel and called 'Bingo!'

"One of the nicest features of the RF-8G was its great fuel load. With 10,152 lb of JP-5 and a very low-drag airframe, it had the perfect combination for photo work. The maximum trap fuel was low in those days because of older landing gear, so you could only bring back about 2,000 lb of fuel."

Small-deck fighter

As the massive infusion of US air power continued, the F-8s were back in the thick of the fighting, although they would be denied an opportunity to add to their MiG-kill list. While the RF-8s, which had never left the front lines, flew an intensive string of reconnaissance missions, the fighters flew from the smaller-deck '27C' carriers on escort and ground-attack missions. In the escort role, the F-8s usually carried only two Sidewinders since a full bag of four AIM-9s placed demands on the fighter, making it nose heavy and reducing its manoeuvrability. The supply of Sidewinders had been low during the early stages of the war; often, F-8s would carry the same missiles through several missions.

Much to the Crusader pilots' frustration, they seldom got any MiG vectors in 1972. They firmly believed that the North Vietnamese would not engage Crusaders and would wait until the F-8s were out of the area before launching to pounce on other American aircraft, especially the Air Force F-4 bomber formations. Although the F-8s flew with the large Alpha strike formations they were never attacked by MiGs, yet the USAF formations were constantly engaged by enemy fighters.

By 1972, the F-8 had nearly disappeared from fighter squadrons. Some squadrons transitioned to Phantoms; some even made the change early enough to fly F-4s in combat

The Schoolhouse

As fighter Crusaders left the fleet, the traditional training squadron, VF-124, was tasked with introducing crews to the new Tomcat. VFP-63 was given the 'Crusader College' task on 1 September 1972. A few fighters were on strength for use as hacks and continuity trainers.

Above: Photographed on a pre-cruise training flight over the California Sierras, this RF-8G is from VFP-63's* Hancock *detachment. The pilot has stuffed his charts between the forward windscreen and instrument panel, the standard map stowage location for all Crusader pilots.

Above left: Having previously briefly operated fighter Crusaders, intended for the escort role, VFP-63 again acquired surplus fighter aircraft in the mid-1970s. Seen in 1979, this was one of the unit's utility F-8Js.

in 1972. By the last full year of the war, only four fighter squadrons flew the F-8J – VF-24 and VF-211 in the *Hancock*, plus VF-191 and VF-194 in the *Oriskany*. Of course, VFP-63's detachments still flew the RF-8G.

The '27C' carriers had largely been retired by this time, too, which limited the deck space available to the Crusader. The older ships like the *Ticonderoga*, *Intrepid*, *Shangri-la* and *Bon Homme Richard* had retired from service, leaving only the *Hancock* and *Oriskany*. Also, Crusader squadrons, especially those in the Atlantic Fleet, were simply decommissioned. Long-time Atlantic Crusader units VF-62 and VF-13 retired in 1969.

In keeping with its long period of service and sterling combat record, the Crusader eventually boasted five pilots who attained more than 3,000 hours in various models of the F-8. The first man to gain the magic number of hours was Commander Richard A. 'Pete' Peters, who flew his 3,000th hour in the F-8 in November 1971. Peters also accumulated nearly 800 carrier landings in the F-8, more than any other Crusader pilot. Commander (later Rear Admiral) David R. Morris followed in July 1972. MiG-killer Commander John B. Nichols III flew his 3,000th hour in August 1973. Lieutenant Commander (later Vice Admiral) Jerry Unruh got there in September 1974. Commander (later Rear Admiral) W. F. Flagg became the fifth and last 3,000-hour Crusader pilot in 1978 and, with 3,272 hours, also garnered the high-time slot of all F-8 pilots.

The F-8 retires

While VF-24 and -211 prepared to transition to the F-14, VF-191 and VF-194 remained with the *Oriskany* for one more WestPac cruise. The 'Mighty O' began its 16th WestPac deployment on 16 September 1975. CVW-19 included the two F-8J squadrons and three A-7 squadrons, as well as Det 4 of VFP-63. The majority of the air wing's aircraft had been craned on board the old carrier at NAS Alameda and had not been allowed to fly during the transit to Hawaii, presumably to reduce wear and tear on the carrier's gear and the aircraft.

CVW-19 operated off the Philippines in the Scarborough Shoals area, participating in several exercises with the Air Force. The Crusaders flew ACM against Marine AV-8A Harriers, recent additions to the Corps on deployment to Cubi. A typhoon cut the deployment short, and the *Oriskany*, having returned to the Philippines, was ordered home early. Avoiding the Malaccan Straits because of pirate activity, the carrier fought heavy weather throughout its transit. Eventually, on 3 March 1976, the old ship tied up at the Alameda piers and was retired shortly afterward. Commander Jack Hamilton, CO of VF-194, made the last trap in a fleet F-8.

The F-8 retired from the fleet, and VF-191 and VF-194 transitioned for a short while to Phantoms. Then, these two veteran squadrons also retired. All Navy Crusader activity now centred on VFP-63, which supplied light-photo dets.

Another milestone came on 26 August 1975, when Lieutenant Jerry Tucker became the last of 1,630 graduates of Crusader College, now transferred to VFP-63. Already an experienced F-8 pilot with 235 combat missions with VF-211 during the 1972 cruise in Vietnam, Tucker went through the photo training syllabus. (Tucker had been one of the VF-211 F-8J pilots who had evidently scared a MiG-17 pilot out of his aircraft on 23 May 1972.)

On 19 May 1976 the Navy's last fighter F-8 lined up on Miramar's Runway 24-Left. Lieutenant Frank Meyers was at the controls of F-8J BuNo. 149215 as it began its last flight to the storage facility at Davis-Monthan AFB.

'Leatherneck' Crusaders in Vietnam

While Navy squadrons flew the major portion of Crusader sorties in Vietnam, there were five US Marine Corps squadrons that saw combat. As previously mentioned, VMF(AW)-212 was the second fighter squadron during CVW-16's 1965 cruise in *Oriskany*. The CO of the 'Lancers', Lieutenant Colonel Charles Ludden, took over the wing when Commander James Stockdale was shot down in September. During their tour with CVW-16,

Wearing the all-over grey scheme adopted in the late 1970s, but with the further reduced conspicuity markings of the early 1980s, a VFP-63 takes off. The Power Eye modification programme installed J57-P-420 engines from redundant F-8Js in the RF-8G, giving a considerable increase in performance. Jetpipe intakes were the key external feature of the uprated aircraft.

Iran crisis

During the frustratingly long Iranian hostage crisis in 1979-80, Navy carriers steamed in the Indian Ocean as near as they could get to Iran. VFP-63's photo dets performed yeoman service during the long cruises, serving with Det 2 aboard Coral Sea (illustrated below) and Det 5 aboard Nimitz.

***Reserve Air Wing 20 F-8s flew from the Crusader's ancestral home at NAS Dallas, both squadrons wearing variations on the 'Lone Star State' flag of Texas. The F-8H was operated by VF-201 and VF-202 (illustrated) from 1970 to 1976, when the units transitioned to the F-4. Initial carrier qualifications were undertaken aboard* John F. Kennedy.**

the 'Lancers' flew 3,018 combat hours and 1,588 combat sorties over North and South Vietnam. One pilot, Captain Harlan P. Chapman, was shot down and captured. He ejected from his F-8E on 5 November 1965, 30 miles (48 km) east of Hanoi, and was repatriated 7.5 years later in February 1973, having been promoted to lieutenant colonel during his imprisonment. However, most of the Marines' activity came from shore-based squadrons. In Vietnam, the fixed-wing jet squadrons operated mainly from two bases, Da Nang and the smaller, but important, base at Chu Lai, 55 miles (89 km) south of Da Nang.

As the influx of squadrons continued throughout 1965, VMF(AW)-312 brought its F-8Es to Da Nang on 19 December as part of Marine Aircraft Group (MAG) 11. The squadron had fought to go to Vietnam after learning it was to rotated back to the US from Japan. Lieutenant Colonel R. B. Newport and his men demanded a chance to join their fellow Marines, and had flown 718 combat missions by February 1966.

'Death Angels' at Da Nang

VMF(AW)-312 returned home to transition to F-4s, but left its F-8Es in Vietnam for its replacement, VMF(AW)-235, led by Lieutenant Colonel George A. Gibson. The 'Death Angels', whose squadron motto was 'Ride Nunc' (Laugh Now), quickly became the most recognised Marine Crusader squadrons, sporting bright red noses with white stars. Arriving at Da Nang on 1 February 1966, '235 quickly got into the action. (They were sometimes called the 'Bozo Noses' after a popular television-clown personality.)

VMF(AW)-235 was relieved by VMF(AW)-232, under Lieutenant Colonel N. M. Trapnell Jr, on 15 November 1966. The 'Red Devils' took over '235's veteran F-8Es and began flying combat missions in December. The F-8Es were heavily involved in ground-support missions, the Crusader being the only type which could carry 2,000-lb bombs, which were very effective against the enemy concentrations in the dense jungles.

On the West Coast, CVWR-30 had two Crusader squadrons for fighter cover. VF-301 and VF-302 (illustrated) flew the F-8K model from Miramar.

During the 1968 siege of Khe Sanh, VMF(AW)-235 flew in support of Operation Niagara, the massive air operation that included Navy, Marine and Air Force aircraft in a continuous attack against Communist positions.

Then-Captain (later Colonel) David C. Corbett remembered his time with 235. "We flew mission after mission, dropping our big bombs only about 300 ft from our own positions, the closest we'd ever tried. The bombs had delayed fuses, which allowed them to penetrate 2-3 ft into the ground before they exploded. When they went off, whole sections of the tunnels would collapse. The plan worked better than we expected and the enemy's drive to take Khe Sanh was squashed. I can't imagine how the grunts felt about us dropping so close, but they apparently had a lot of confidence in us, and it paid off."

Rudimentary bombsight

Corbett had much experience with the huge Mk 84s. Although he complained that the F-8's bomb sight was not very good, he recalled that he and other pilots used a simple grease-pencil mark on their sights which, when properly aligned in conjunction with the individual pilot's most comfortable seat position, gave fairly consistent results. "When four Crusaders were loaded with two Mk 84s fused with 36-in 'Daisy Cutters' each, the devastation to the landscape was incredible. On one mission, I remember that with a total of eight 2,000-pounders we completely levelled an entire mountain. I was so impressed that I actually went down low and slow to see the results. It was terrible, but very effective. Another time, I dropped these same weapons on troops in the open. The enemy was literally cut in half. The Daisy Cutter exploded 36 in above the ground, and in my opinion, against troops in the open and for clearing landing zones, there was no more effective weapon."

Besides the four Marine squadrons that flew F-8Es in Southeast Asia, a fifth squadron, VMCJ-1, flew the RF-8A. One of three Marine composite squadrons, VMCJ-1 also

Reserve fighters

Below: When the Crusader first entered the Reserve fleet in 1965, the aircraft were operated jointly by Navy and Marine crews. This F-8B was assigned to VMF-511, based at Willow Grove.

In 1971 the Marine Corps Reserve was reorganised into a coherent force. VMF-321 at NAF Washington had originally shared F-8Bs with the Navy, but between 1971 and 1973 flew immaculately marked F-8Ks, restyling itself as the 'Black Barons'.

operated the Korean War-vintage Douglas EF-10B Skyknight. Both aircraft performed yeoman service throughout 1964-68. The photo-Crusaders supported Navy, Air Force and Marine operations, flying missions over North and South Vietnam and Laos. As mentioned earlier, VMCJ-1 also sent personnel and aircraft on detachment to several Navy carriers immediately after the Gulf of Tonkin Incident in August 1964 to bolster VFP-63's dets. During 1966, in a time of intense operations and combat, VMCJ-1 flew nearly 1,800 reconnaissance sorties.

By October 1966 the RF-8A was supplanted by the RF-4B Phantom, and the Marine photo-Crusaders quickly disappeared from service, leaving the F-8Es of VMF(AW)-232 and VMF(AW)-235 to carry on the Crusader name in Southeast Asia. The Marines lost 12 F-8Es to flak in Vietnam, plus two during enemy rocket attacks on bases. Eight E models and one RF-8A were lost operationally in Southeast Asia. (Operational losses are considered resulting from non-combat related problems, such as system malfunction, weather, and pilot error.) By comparison, the Navy lost 10 fighters to SAMs and 42 to flak and small arms. Twenty Navy RF-8s were lost to flak. Thus, including three confirmed losses to MiGs in 1966 and one possible in 1967, the Navy lost 56 F-8s and 20 RF-8s in combat. Operationally, 58 fighters and nine photo-ships were lost. Overall, a little over 13 per cent of all Crusaders manufactured were lost in Southeast Asia.

VFP-63 carries on, 1977-82

Although the RF-8G's retirement had been scheduled to coincide with the retirement of the 'Essex'- and 'Midway'-class carriers, VFP-63 continued to provide detachments for the Navy's carriers throughout the late 1970s, even as plans were solidified for the retirement of the aircraft's sometime-competitor, the RA-5C Vigilante. The Vigilante left in 1979, and, suddenly, the only operational tactical-reconnaissance system ready and able to deploy in carriers was the venerable RF-8G. (The long-nosed RF-4B flown by VMFP-3 occasionally deployed in the *Midway* and *Coral Sea*, but the photo-Phantom's limited numbers did not allow for greater use.)

Above: The photo-Crusader reserve fleet was organised into two squadrons serving the Pacific and Atlantic Reserve air wings. Here an RF-8G from VFP-206 prepares to launch from 'FDR' during carquals in 1971.

Left: Each Naval Reserve air wing had its own refuelling assets. Here a VFP-306 RF-8G tops up from a VAK-308 KA-3B.

Below: Black-tailed RF-8Gs of VFP-306 maintained the photo-bird's reputation for outstanding results until decommissioned in September 1984. The tail markings were a stylised 'ND'.

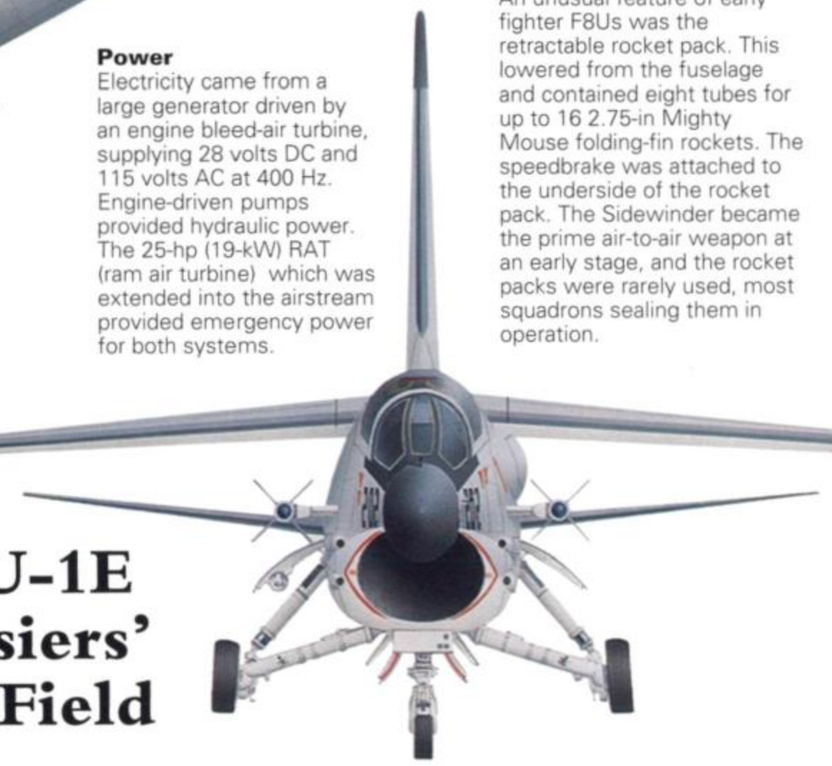
Ejection seat
Production aircraft up to and including the F8U-2N were initially fitted with a lightweight high-altitude seat built by Vought. This was replaced in production aircraft by the Martin-Baker Mk F5 from the F8U-2NE, and retrofitted to older aircraft from 1962. From April 1968 the rocket pack-equipped Mk F7 was introduced.

Nav/comm equipment
The F8U-1 and -1E had ARC-27A UHF transceiver, ARA-25 UHF direction finder, ARN-14E or ARN-21 VHF navigation receiver and an APX-6B IFF transponder.

Nosewheel
The nosewheel was mounted on a pivoted beam, with powerful damping on the opposite end. Original production aircraft had spoked wheels, later changed for solid units.

Rocket pack
An unusual feature of early fighter F8Us was the retractable rocket pack. This lowered from the fuselage and contained eight tubes for up to 16 2.75-in Mighty Mouse folding-fin rockets. The speedbrake was attached to the underside of the rocket pack. The Sidewinder became the prime air-to-air weapon at an early stage, and the rocket packs were rarely used, most squadrons sealing them in operation.

Power
Electricity came from a large generator driven by an engine bleed-air turbine, supplying 28 volts DC and 115 volts AC at 400 Hz. Engine-driven pumps provided hydraulic power. The 25-hp (19-kW) RAT (ram air turbine) which was extended into the airstream provided emergency power for both systems.

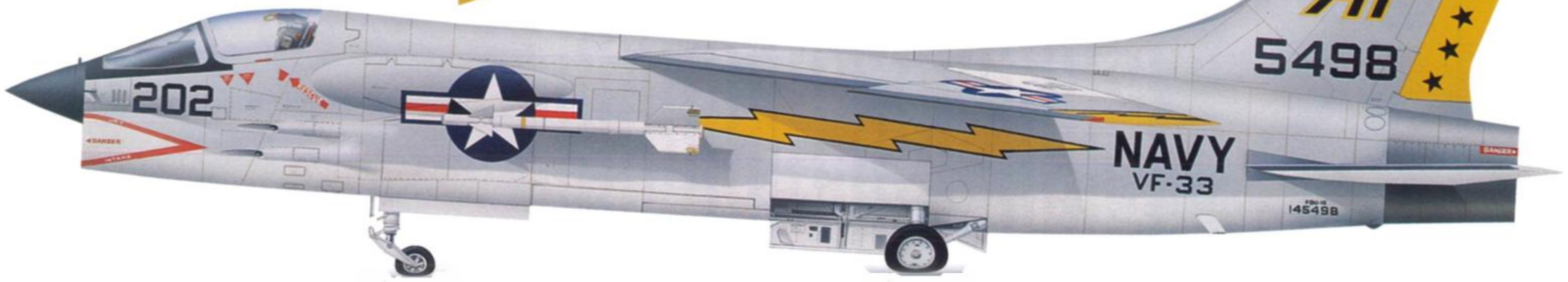


Vought F8U-1E VF-33 'Tarsiers' NAS Cecil Field 1961

The 'Tarsiers' operated the F8U-1E only briefly before upgrading to the F-8E in 1962. First flying on 3 September 1958, the variant was basically similar to the F8U-1 except for exchanging the early APG-30 gun-ranging radar for the AN/AWG-3 fire control system and its APS-67 airborne interception radar. This gave limited detection capability, but the F8U-1E remained essentially a day fighter, and it was not until the adoption of the APQ-83 in the F8U-2N (F-8D) that the Crusader could perform the all-weather fighter mission. Only 130 F8U-1Es were built, and 61 were rebuilt as F-8Ls. The reworked aircraft retained the J57-P-4 engines, and were fitted with attachment points for the ventral strakes, although the fins were never actually fitted.

Cockpit
The F8U-1E's cockpit was dominated by a large circular screen display for the APS-67 radar at top centre, underneath which was the primary attitude indicator. On either side was a column of three primary flight instruments (radio altimeter, airspeed/Mach indicator and barometric altimeter to the left, and course indicator, radio magnetic indicator and turn-and-bank indicator to right). Two more columns of instruments were oustide these. The left-hand console had the radar controls, throttle and autopilot, while the right-hand console had nav/comms controls and aircraft systems.

Main undercarriage
The main undercarriage was supported by two struts, the top one of which had shock absorbers fitted. The struts were pivoted and braced by a retraction jack strut at the rear. Gear retracted forward into the main fuselage-side well, with the aft portion of the retraction strut covered by a small auxiliary door.



F-8 weapons and cutaway

Air-to-ground weapons

The YF8U-2 displays the principal weapon options for the late-model Crusaders. On the pylons and at the ends of the ground display are 5-in Zuni rockets, a maximum of 16 available for each side of the aircraft for a total of 32. Four Sidewinders are shown with the four internal cannon, together with bomb racks. The bomb display consists of various Mk 80 series in appropriate numbers for the aircraft's two bomb-carrying pylons, consisting of Mk 81 250-lb (six per side), Mk 82 500-lb (four), Mk 83 1,000-lb (two) and Mk 84 2,000-lb (one). In the centre are two AGM-12 Bullpup-As, this weapon having a 250-lb (113-kg) warhead. Under the sheet is an example of the larger and then-secret AGM-12C Bullpup-B. This was also available with a nuclear warhead, as the AGM-12D. Crusaders were wired for 'special weapons', but the use of bombs such as the Mk 43 is more likely than Bullpups.

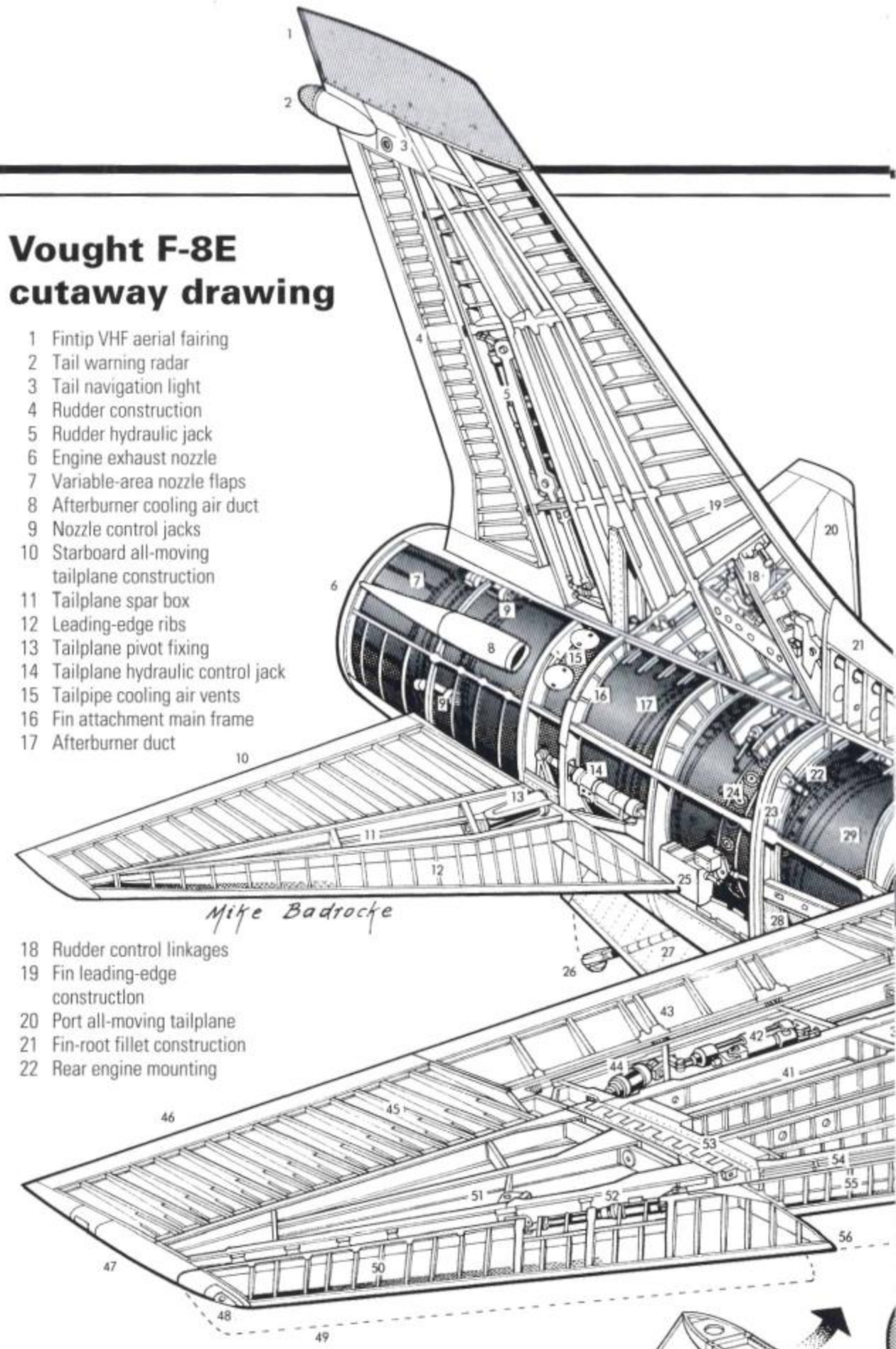
Left: An early F8U-2NE (F-8E) taxis out for a bomb-drop test carrying a pair of dummy Mk 83 1,000-lb (454-kg) weapons on a TER (triple ejector rack). The bomb shapes are brightly painted to allow their trajectories to be easily followed.

Right: Zuni rockets were usually fired from the cheek stations using LAU-33 or -35 two-round launchers. In addition, the F-8 could carry four-round LAU-10 launchers (with aerodynamic frangible fairings) from TERs on the wing pylons.

Above: One little-used weapon was the Bullpup, seen here on the YF8U-2N. The missile used radio command guidance and in this AGM-12C version had a 1,000-lb (454-kg) warhead.

Right: Mk 82 bombs were routinely carried in a slant-four arrangement from an MER.

Vought F-8E cutaway drawing



1 Fintip VHF aerial fairing
2 Tail warning radar
3 Tail navigation light
4 Rudder construction
5 Rudder hydraulic jack
6 Engine exhaust nozzle
7 Variable-area nozzle flaps
8 Afterburner cooling air duct
9 Nozzle control jacks
10 Starboard all-moving tailplane construction
11 Tailplane spar box
12 Leading-edge ribs
13 Tailplane pivot fixing
14 Tailplane hydraulic control jack
15 Tailpipe cooling air vents
16 Fin attachment main frame
17 Afterburner duct
18 Rudder control linkages
19 Fin leading-edge construction
20 Port all-moving tailplane
21 Fin-root fillet construction
22 Rear engine mounting
23 Fuselage break point double frame (engine removal)
24 Afterburner fuel spray manifold
25 Tailplane autopilot control system
26 Deck arrester hook
27 Starboard ventral fin
28 Rear fuselage fuel tank -
29 Pratt & Whitney J57-P-20 afterburning turbojet
30 Engine bay cooling air louvres
31 Wingroot trailing-edge fillet
32 Bleed air system piping
33 Engine oil tank (85 US gal/32 litres)
34 Wing spar pivot fixing
35 Hydraulic flap jack
36 Starboard flap
37 Control rod linkages
38 Rear spar
39 Engine accessory gearbox compartment
40 Inboard wing panel multi-spar construction
41 Starboard wing integral fuel tank, total fuel system capacity 1,348 US gal (5103 litres)
42 Aileron power control unit
43 Starboard drooping aileron construction
44 Hydraulic wing fold jack
45 Trailing-edge ribs
46 Fixed portion of trailing edge
47 Wingtip fairing
48 Starboard navigation light
49 Leading-edge flap, lowered position
50 Leading-edge flap rib construction
51 Outer wing panel spar construction
52 Leading-edge flap hydraulic jack
53 Wingfold hinge
54 Front spar
55 Leading-edge flap inboard section
56 Leading-edge dog-tooth
57 Wing pylon
58 AGM-12B Bullpup A air-to ground missile
59 Starboard mainwheel

Air-to-air weapons

Left: 'Ordies' load AIM-9Ds on to an F-8E. The Sidewinder was the main air-to-air weapon of the F-8, used mainly in AIM-9B (long-nose) and AIM-9D (short-nose) IR versions. The rare AIM-9C radar-guided version was occasionally carried.

Vought F-8E cutaway drawing

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59 Starboard mainwheel
60 Main undercarriage leg strut
61 Shock absorber strut
62 Hydraulic retraction jack
63 Landing lamp
64 Wheel bay doors
65 Main undercarriage pivot fixing
66 Wing spar/front engine mounting main bulkhead
67 Engine compressor intake
68 Wingroot rib
69 Centre-section fuel tank
70 Wing spar carry-through structure
71 Dorsal fairing
72 Port flap jack
73 Port plain flap, lowered position
74 Port drooped aileron, lowered position
75 Aileron power control unit
76 Fuel system piping
77 Wing-fold hydraulic jack
78 Fixed portion of trailing edge
79 Port wing folded position
80 Wingtip fairing
81 Port navigation light
82 Port outboard leading-edge flap, lowered
83 Outboard flap hydraulic jack
84 Leading-edge dogtooth
85 Wing-fold hinge
86 Inboard leading-edge flap hydraulic jacks
87 Port wing integral fuel tank
88 Anti-collision light
89 Missile system avionics
90 Two-position variable-incidence wing, raised position
91 Intake trunking
92 Wing incidence hydraulic jack
93 Fuselage upper longeron
94 Air system exhaust heat shield
95 Main fuselage fuel tank
96 Airbrake hydraulic jack
97 Airbrake housing
98 Ventral airbrake, lowered
99 Rocket launch tubes
100 Rocket launcher pylon adaptor
101 Zuni folding-fin ground attack rockets (8)
102 Emergency air-driven generator (RAT)
103 Liquid oxygen bottle (LOX)
104 Fuselage stores pylon
105 Intake duct
106 Heat exchanger air exhaust
107 Air conditioning plant
108 Dorsal fairing
109 Upper fuselage access panels
110 Electronics bay and electrical power system
111 Fuselage pylon adaptor
112 Missile launch rails
113 AIM-9 Sidewinder air-to air missiles (4)
114 Inflight-refuelling probe, extended
115 Refuelling probe housing door
116 Ammunition tanks (144 rounds per gun)
117 Avionics system inertial platform
118 Ammunition feed chutes
119 Gun bay gas vent panel
120 Mk 12 20-mm cannon
121 Spent cartridge case/link collector chutes
122 Gun compartment access panel
123 Nosewheel doors
124 Nosewheel
125 Pivoted axle beam
126 Nose undercarriage leg strut
127 Cannon barrels
128 Radio and electronics equipment bays
129 Canopy hinge point
130 Cockpit rear pressure bulkhead
131 Ejection seat rails
132 Pilot's Martin-Baker ejection seat
133 Face blind firing handle
134 Cockpit canopy cover
135 Safety harness
136 Canopy emergency release
137 Pilot's starboard side console panel
138 Cockpit floor level
139 Cannon muzzle blast troughs
140 Intake duct framing
141 Radar cooling air piping
142 Rudder pedals
143 Control column
144 Instrument panel shroud
145 Engine throttle control
146 Radar gunsight
147 Bullet-proof windshield
148 Infra-red seeker head
149 Radar electronics package
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151 Engine air intake
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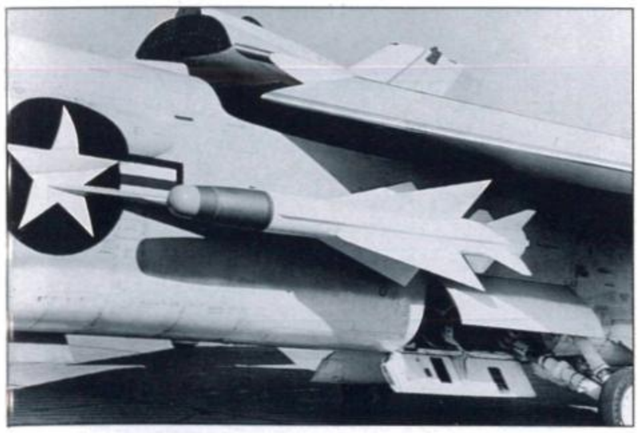

French F-8E(FN)s were able to launch AIM-9s, and occasionally carried them. However, the indigenous MATRA missiles were more prevalent. Used regularly in the early days of French F-8 operations, the R.530 (left, seen on a US Navy test aircraft) was a large missile with powerful warhead. It came in both infra-red and semi-active homing versions. The smaller infra-red only R.550 Magic (right) has been the more widespread weapon in recent times.

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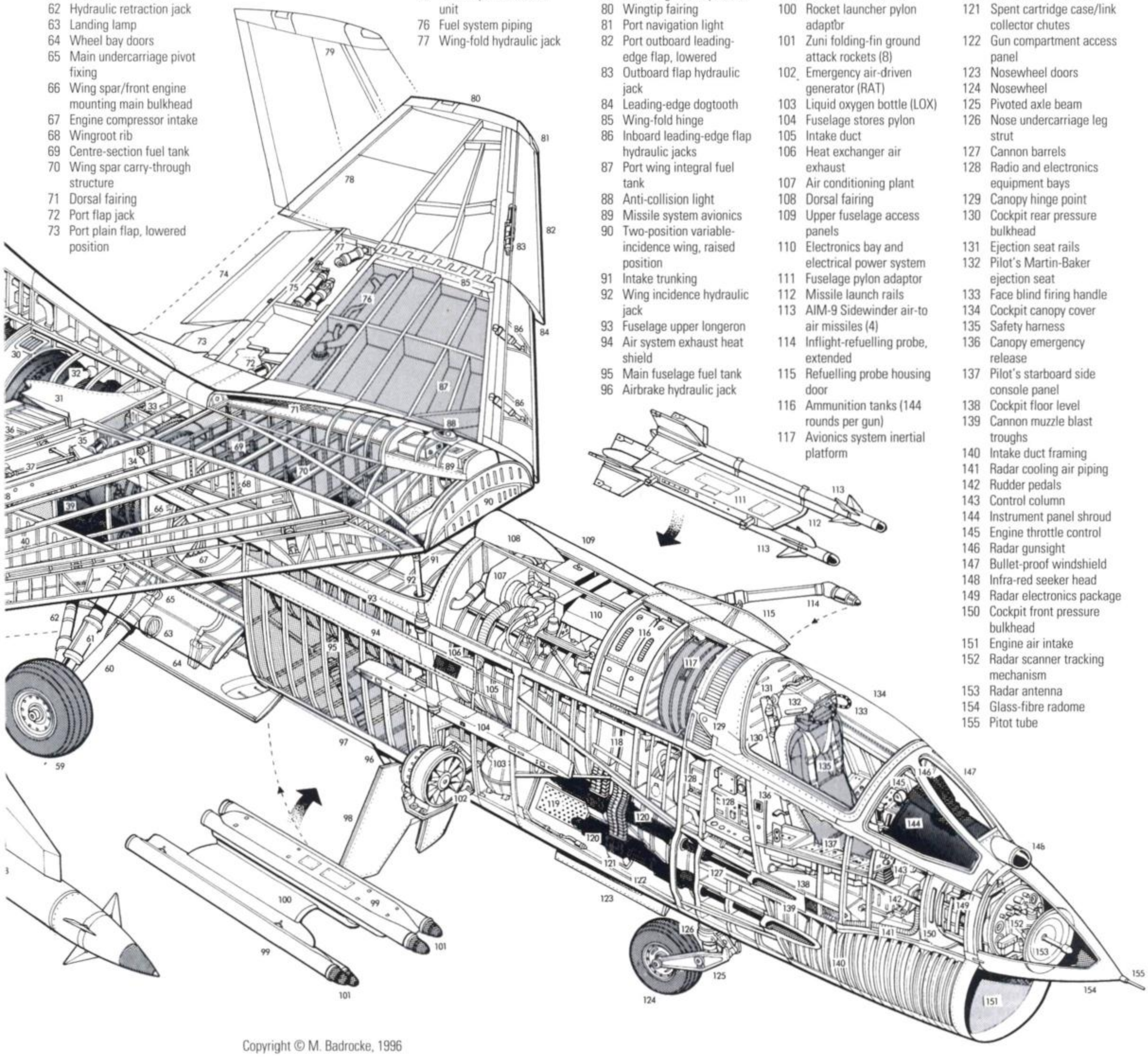

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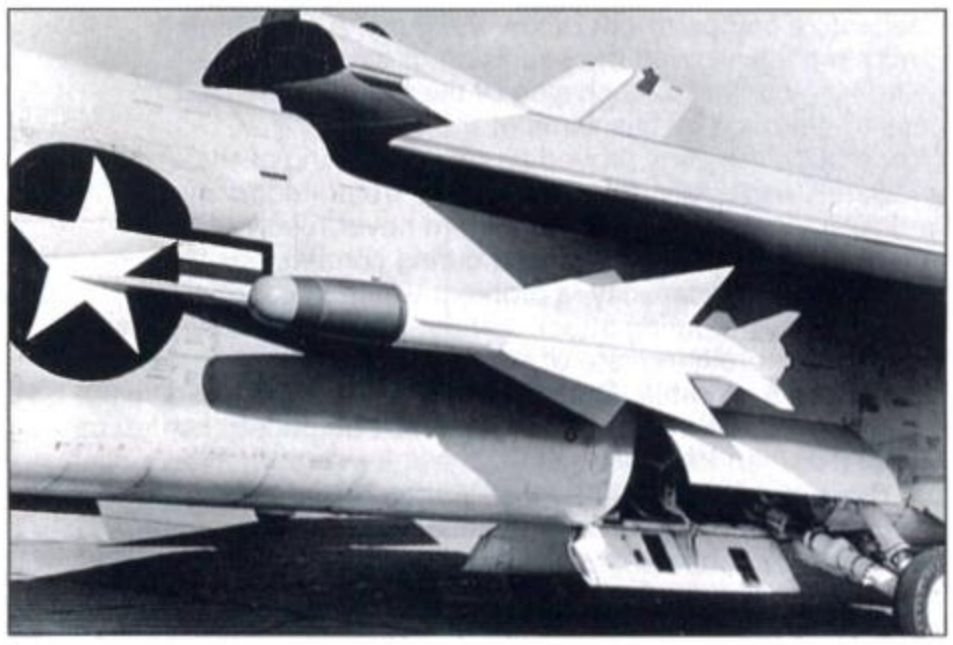

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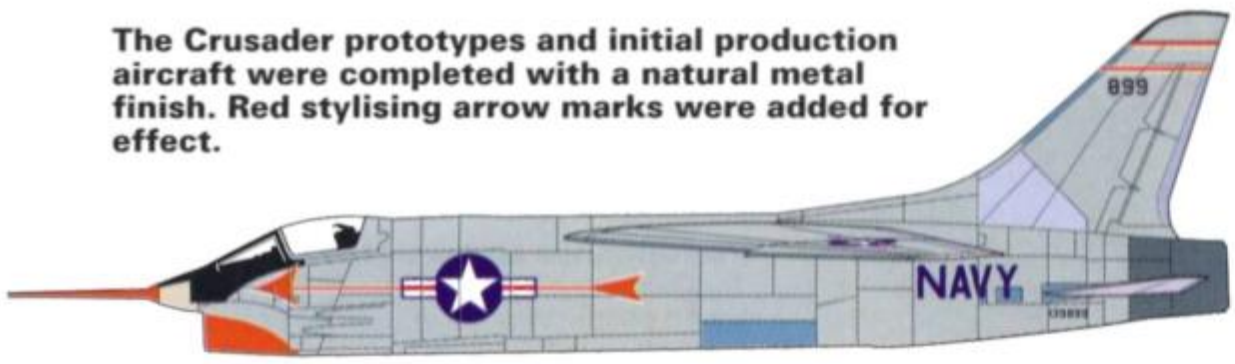
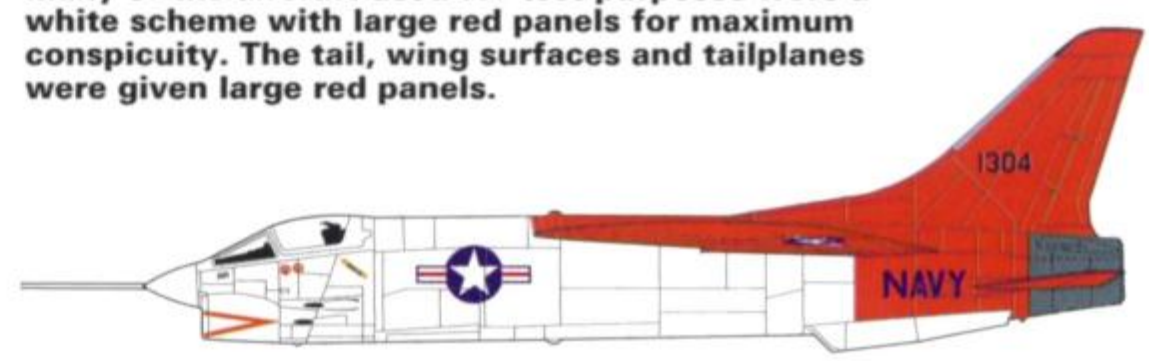
Vought F-8 colours

Prototype/test

The Crusader prototypes and initial production aircraft were completed with a natural metal finish. Red stylising arrow marks were added for effect.

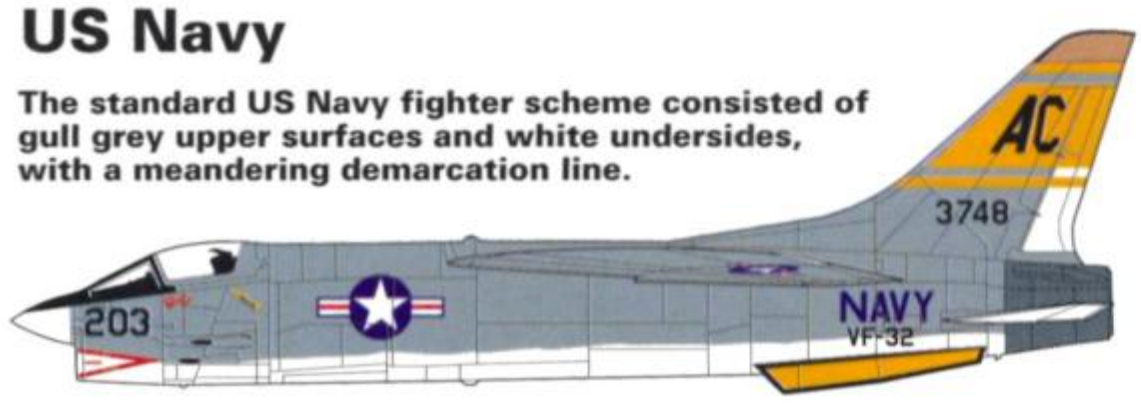


Many of the aircraft used for test purposes wore a white scheme with large red panels for maximum conspicuity. The tail, wing surfaces and tailplanes were given large red panels.

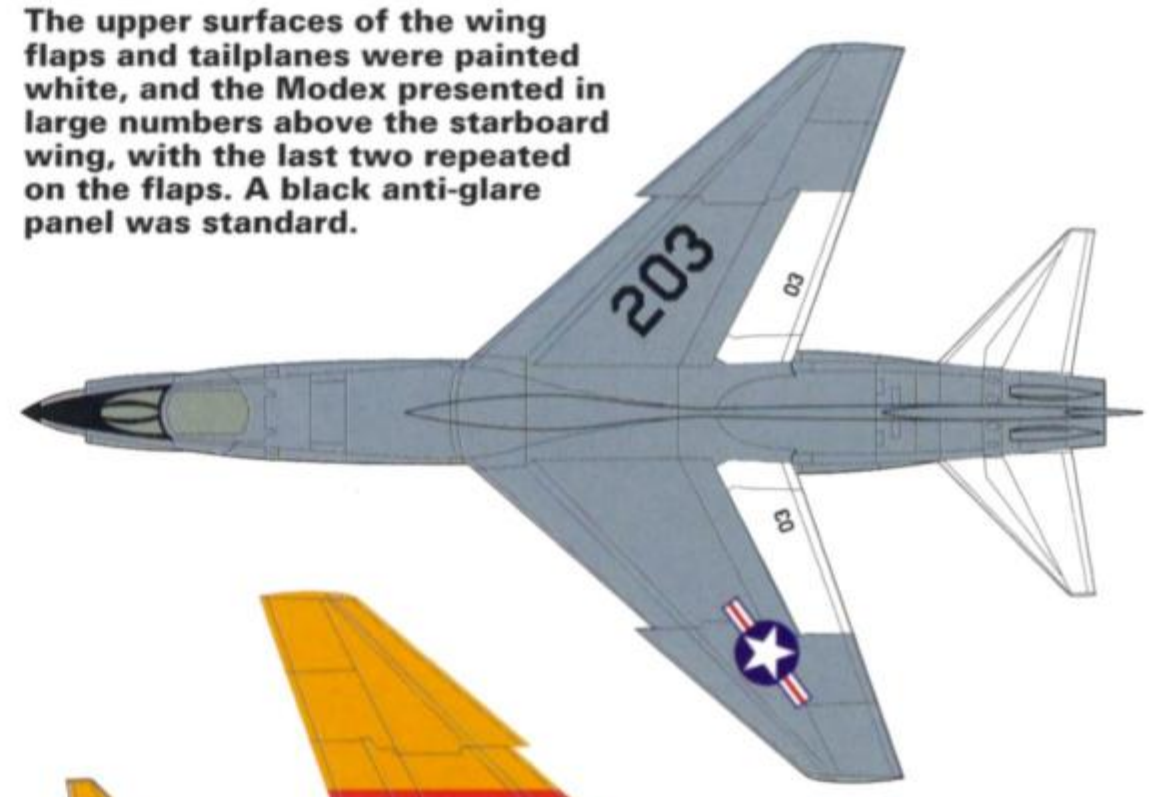


US Navy

The standard US Navy fighter scheme consisted of gull grey upper surfaces and white undersides, with a meandering demarcation line.



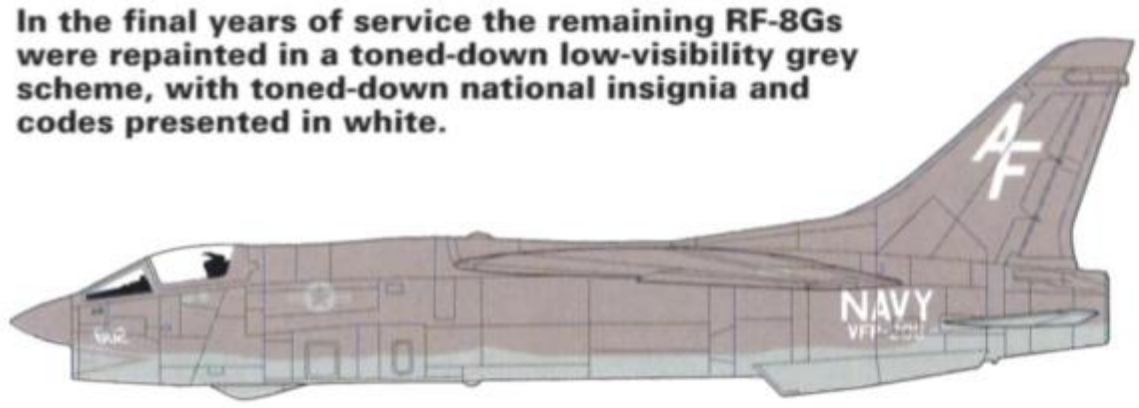
The upper surfaces of the wing flaps and tailplanes were painted white, and the Modex presented in large numbers above the starboard wing, with the last two repeated on the flaps. A black anti-glare panel was standard.

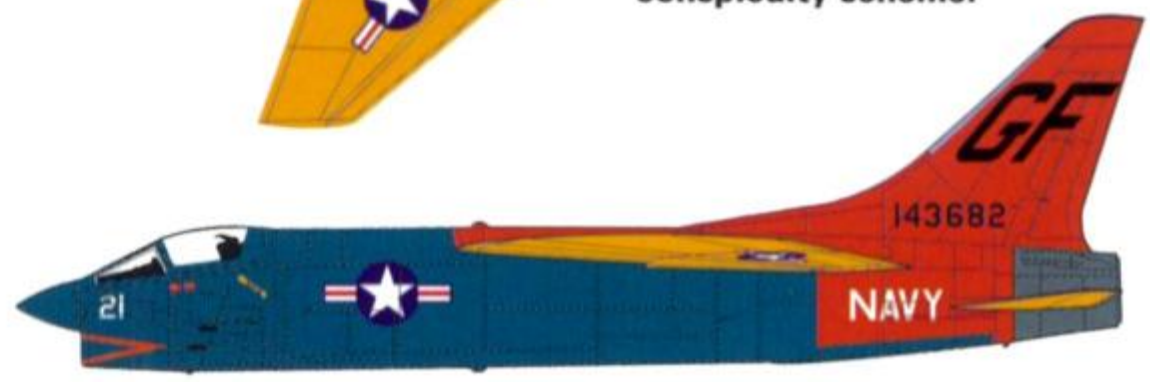


Originally operating in the standard fighter scheme, the RF-8G later adopted this all-over grey scheme, but retained black high-visibility markings.

DF-8F drone controllers mostly wore this high-conspicuity scheme.

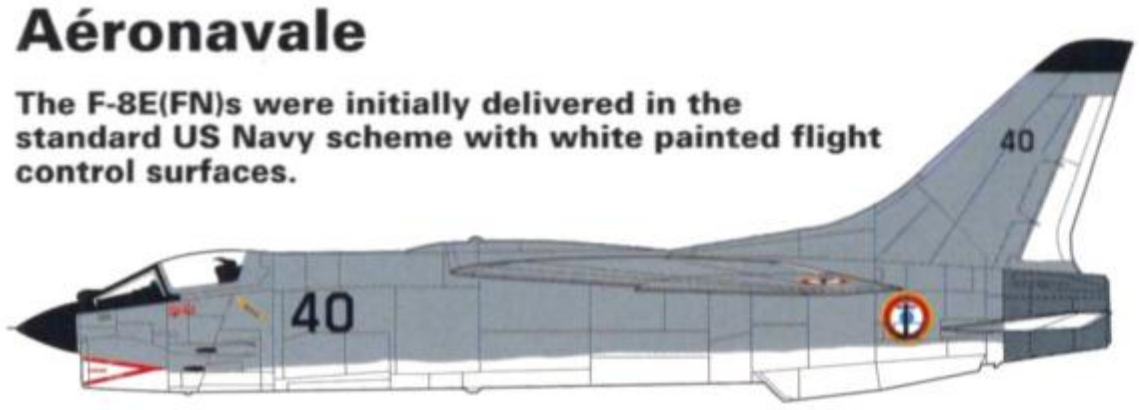
In the final years of service the remaining RF-8Gs were repainted in a toned-down low-visibility grey scheme, with toned-down national insignia and codes presented in white.





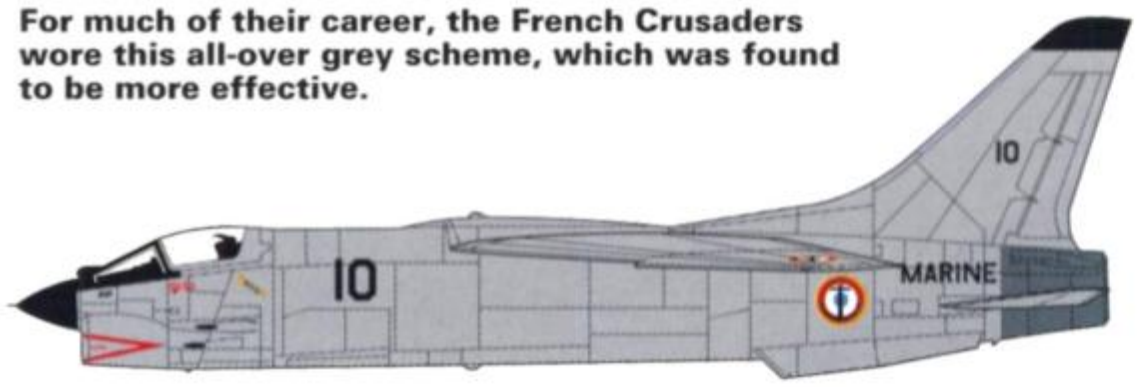
Aéronavale

The F-8E(FN)s were initially delivered in the standard US Navy scheme with white painted flight control surfaces.



Currently, F-8E(FN)s wear this dark grey scheme with toned-down markings and much smaller national insignia. The 12F badge is worn small below the cockpit rails.

For much of their career, the French Crusaders wore this all-over grey scheme, which was found to be more effective.



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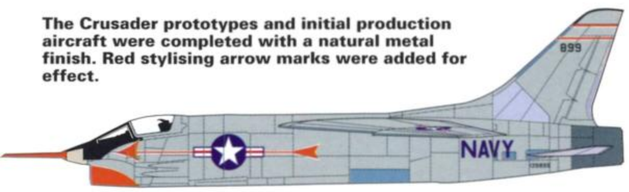

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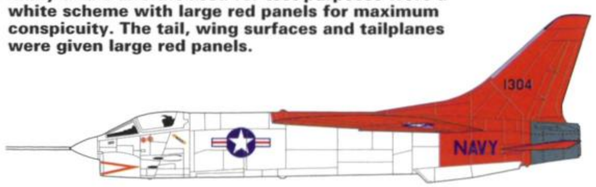

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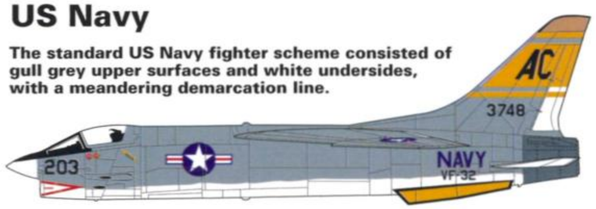

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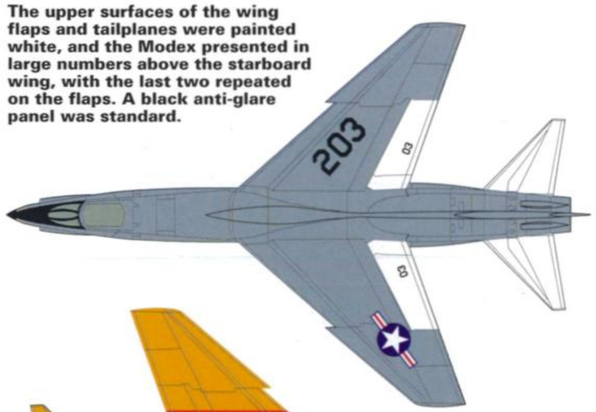

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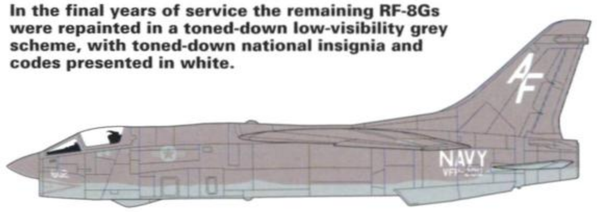

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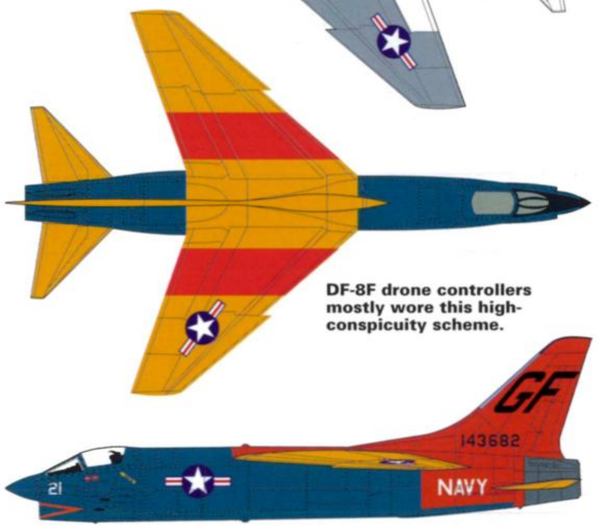

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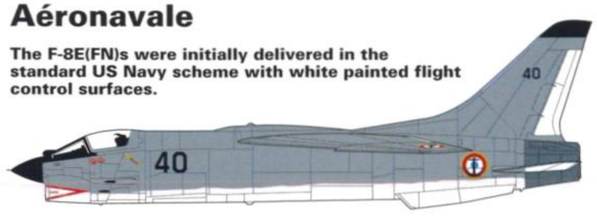

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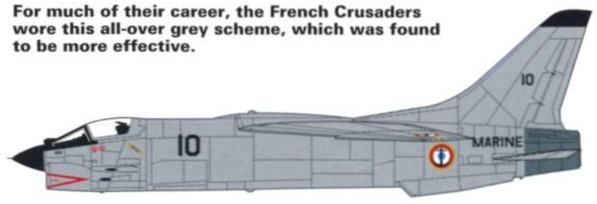


RF-8 details

Above: The Crusader cockpit was well laid-out for a 1950s jet, but was nevertheless complicated compared to today's fighters. Dominating the cockpit of the RF-8G was the circular lens for the downward-view periscope, which allowed the pilot to accurately control the vertical and forward-looking cameras.

Right: This photograph of Glenn's Project Bullet aircraft displays the original camera window layout of the F8U-1P. The rear camera station could mount either vertical or sideways-looking cameras, and was used primarily to mount the three-camera trimetrogon horizon-to-horizon system prior to the more efficient single panoramic camera that was introduced. Note the small window for the pilot's periscope forward of the intake.

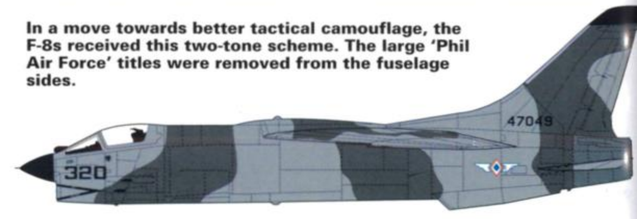
Above: Like most jets of its era, the Crusader had a detachable rear fuselage and tail unit to allow rapid access to the engine for maintenance or removal.

Right: The RF-8G had a retractable refuelling probe housed within the fuselage side. Note the pull-out lower access step and two drop-down foot/handholds above it.

Philippines

Philippine aircraft were initially delivered in standard US Navy colours. The white undersides were replaced by a very light grey.

In a move towards better tactical camouflage, the F-8s received this two-tone scheme. The large 'Phil Air Force' titles were removed from the fuselage sides.



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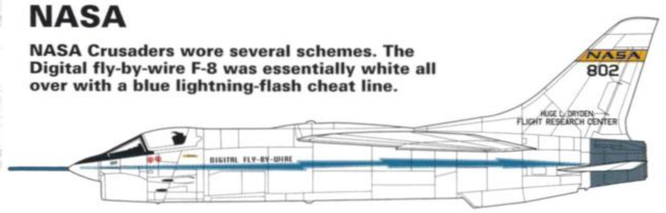

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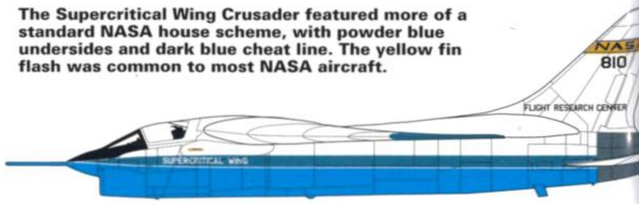

Fire control system and nav/comms equipment
The F-8E featured the AN/AWG-4 fire control system, the principal components being the AN/APQ-94 radar (upgraded to APQ-124 in early F-8J and APQ-149 in late F-8J), EX-16 aircraft fire control system, Mk 11 reflector gunsight, gyroscope and computer. The AAS-15 infra-red seach and track system also allowed passive detection of targets. Data from the radar was displayed on a rectangular screen in the top centre of the instrument panel, and had varying range displays. The system could cue the AIM-9 Sidewinder missile.

Nav/comms equipment included the APA-52 radio set/TACAN, APN-22 radar altimeter, APA-98 coder group, A/NAS Q/17B integrated system (controlling ARC-27A UHF transceiver, APX-6B IFF transponder and ARA-25 UHF direction finder), AES-6 autopilot and MA-1 gyro-stabilised magnetically-slaved compass. Fuse control was handled by the AWW-1 system.

Raising wing
The characteristic variable-incidence wing fulfilled two principal functions: it provided extra lift during take-off and allowed the aircraft to land with the fuselage (as opposed to the wing) at a low incidence, with beneficial effects on pilot visibility and undercarriage size/weight. During landing the wing was flying at an incidence of 12.5°, while the fuselage landed at 5.5° incidence. When boundary layer control was introduced on the F-8E(FN) and F-8J the wing incidence was reduced to 5° (from 7°). The wing was actuated by a single hydraulic strut on the forward starboard position. This unit did not seem strong enough to handle the huge loads placed on it, and the actuator only weighed around 30 lb (13.6 kg). When retracted it was 34 in (0.86 m) long, and it extended 17½ in (0.44 m). Working at a hydraulic pressure of 3,000 lb/in² (20685 kPa), the strut was designed to exert a force of 5,400 lb (24 kN) for lowering the wing after take-off and 1,700 lb (7.56 kN) for raising the wing, the latter function obviously being aided greatly by the forces of gravity and aerodynamics.

Vought F-8E Crusader
VF-191 'Satan's Kittens'
USS *Bon Homme Richard*
South China Sea, 1966

This F-8E is depicted as it appeared at the end of VF-191's 1965/66 combat cruise. It was assigned to the squadron's commanding officer, Commander Billy Phillips, and wears the 'double nuts' Modex as the CAG-bird. Other CAG markings include the legend 'Attack Carrier Air Wing Nineteen' on the fuselage under the wing, and the large tail diamond is faceted with red, yellow, blue and orange to signify the squadrons within the wing. The marking under the refuelling probe fairing is the 'Satan's Kitten'.

VF-191 received its first F8U-1 in June 1960, going to sea with the Crusader aboard Bon Homme Richard in 1961. In 1963 the squadron upgraded to the F-8E. A total of eight cruises was made in the war zone, always partnered by the 'Red Lightnings' of VF-194. The first two cruises were in Bon Homme Richard (28 January 1964 to 21 November 1964 and 21 April 1965 to 13 January 1966). During the second of these cruises three F-8s were lost to AAA and one to a SAM. After a period back at Miramar, VF-191 and VF-194 transferred to Ticonderoga for a combat cruise (15 October 1966 to 29 May 1967) during which one F-8E was lost to AAA. The next cruise (27 December 1967 to 17 August 1968) was also aboard 'Tico', and was highlighted by the MiG-kill of LCdr John Nichols on 9 July. Upon their return from the war zone, both squadrons upgraded to the F-8J in preparation for more combat cruises. Flying from Oriskany, there were four relatively uneventful voyages (16 April 1969 to 17 November 1969, 14 May 1970 to 10 December 1970, 14 May 1971 to 18 December 1971 and 5 June 1972 to 30 March 1973).

The 'Kittens' made two more WestPac cruises aboard Oriskany (18 October 1973 to 5 June 1974 and 16 September 1975 to 3 March 1976). The final cruise was the last by an active-duty F-8 fighter squadron, and on return VF-191 immediately began the transition to the F-4J. Operations of the Phantom were brief, for after just one cruise in Coral Sea, VF-191 was disestablished. It was later briefly resurrected (1 December 1986 to 29 April 1988) as an F-14 unit.

Cannon
All fighter Crusaders were armed with four Colt-Browning Mk 12 20-mm cannon. The TF-8, had it been ordered, would have carried two. The guns were arranged above each other, with the top weapon being mounted slightly behind the lower gun to accommodate the bulky breeches within the confines of the fuselage. Each cannon had 144 rounds (initially 84, then 125) held in boxes in the top of the fuselage immediately above the breech, allowing a straight-line feed chute into the gun mechanism. The boxes were easily replaced via upward-opening doors in the top of the fuselage. Rounds were chute-fed around the side of the air intakes, and after firing both the links and spent cases were ejected into a compartment below the guns. A vent screen behind the guns allowed the expulsion of gases. A large forward-hinging door in each side of the fuselage allowed access to the main mechanisms of the weapons.

In operation the guns proved prone to jamming of the feed chutes, especially above 3.5 g. This frustrated many a pilot during Vietnam and was a problem never resolved. Another frustration which surfaced during combat was the lack of ammunition capacity, a problem which became especially relevant during attack sorties, when the 660-rounds per minute firing rate of the Mk 12 quickly devoured the 144 rounds available. The gun was a vital part of aiming the Zuni rocket, and the lack of ammunition degraded the effect of these attacks. Although the problem was insoluble simply because there was no room in the packed forward fuselage for more ammunition, a partial palliative was found by simply allowing the pilot to select two (either upper pair or lower pair) or four guns. While halving the weight of fire, this doubled the maximum firing time to about 26 seconds.

Fuselage pylons
The 'cheek' pylons could carry either Sidewinder missiles or Zuni rockets. Initially the single rack was employed, but from the F-8C a twin-attachment Y-rack was an option. For Sidewinder carriage the Aero 3A (AIM-9B) or LAU-7 (AIM-9D) launch rails were fitted, these containing a nitrogen source for the missile. The two-round Zuni rocket tubes were attached to the Sidewinder launch rail. On single-pylon aircraft the LAU-33A/A launcher was used, while Y-rack aircraft had three LAU-33A/A launchers and a single LAU-35A/A tube on the lower port missile rail. The Zuni launchers could be preset on deck for either single or ripple fire, the latter mode firing both at an interval of 0.1 seconds.

Sidewinder missile
Three versions of the AIM-9 were used by the Crusader. The initial variant was the AIM-9B, as seen on this aircraft. This had a long tubular nose housing the IR seeker and a range of about 1.2 miles (2 km). The warhead was 10 lb (4.5 kg) of high explosive with blast fragmentation, and the launch weight was 167 lb (76 kg). The AIM-9C was a rarely employed semi-active radar-guided version with a long tubular nose and a launch weigh of 205 lb (93 kg). The last major model used by the F-8 was the AIM-9D, with a refined seeker head in a short, conical nose. This had a launch weight of 198 lb (90 kg), of which 20 lb (9 kg) was a new high-explosive continuous rod warhead. The effective range was increased over the B to about 2 miles (3 km).

Raising wing
The characteristic variable-incidence wing fulfilled two principal functions: it provided extra lift during take-off and allowed the aircraft to land with the fuselage (as opposed to the wing) at a low incidence, with beneficial effects on pilot visibility and undercarriage size/weight. During landing the wing was flying at an incidence of 12.5°, while the fuselage landed at 5.5° incidence. When boundary layer control was introduced on the F-8E(FN) and F-8J the wing incidence was reduced to 5° (from 7°). The wing was actuated by a single hydraulic strut on the forward starboard position. This unit did not seem strong enough to handle the huge loads placed on it, and the actuator only weighed around 30 lb (13.6 kg). When retracted it was 34 in (0.86 m) long, and it extended 17½ in (0.44 m). Working at a hydraulic pressure of 3,000 lb/in² (20685 kPa), the strut was designed to exert a force of 5,400 lb (24 kN) for lowering the wing after take-off and 1,700 lb (7.56 kN) for raising the wing, the latter function obviously being aided greatly by the forces of gravity and aerodynamics.

Wing configuration and control surfaces
The Crusader's wing was a highly advanced lifting surface which attended to the demands of both high-speed flight and carrier approach. It was of a supersonic laminar-flow modified NACA 65A006 supersonic airfoil section with modified NACA 65A005 at the wingtip. The quarter-chord sweepback was 42° and the wing was set at 5° anhedral. A large dogtooth was incorporated to keep the airflow energised over the outer wing section.

There were two basic aerodynamic configurations: clean/cruise and landing. The principal difference was whether the variable-incidence wing was raised or lowered, and the control surfaces were altered accordingly. Roll control was effected by the ailerons which were located inboard of the wing fold. These large surfaces had a travel of +/- 15° in the clean configuration, but had overridable stops at 9½°. The all-moving tailplane provided all pitch control, while yaw control was effected by the rudder with up to 6° travel either side. In the cruise configuration the leading-edge flaps ('droops') could be lowered for greater lift (6.8° for the centre-section flaps and 7° for the outer flaps).

In the landing configuration with the wing raised, the ailerons were depressed to act as flaperons. The neutral droop position was 20°, augmenting the small pure flap sections next to the fuselage which also had 20° droop. For roll control the limits of aileron travel were extended to 15° up and 45° down to provide adequate authority from the 20° neutral position. The leading-edge flaps were fully depressed (25° centre-section and 27° outer wing), while the tailplanes automatically moved through 5° to offset the pitch change caused by the raising of the wing. To provide greater control authority at low speeds the rudder stops were disenagaged, allowing a travel of 17° to either side. BLC aircraft (F-8E(FN) and F-8J) had double-hinged leading-edge flaps with up to 55° droop on the forward outer sections, while the ailerons and flaps had a 40° setting for landing.

Control surfaces were all hydraulically powered and incorporated artifical feel systems. For directional and lateral feel centring springs and bob-weights were employed, while in pitch the spring was augmented by viscous dampers. Damping/stiffening in yaw was accomplished by a stabilisation system, while a roll damper was employed laterally.

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Another important feature of the F-8E was the introduction of heavy wing pylons, allowing the carriage of bomb loads. Each pylon weighed 179 lb (81 kg) and was 10 ft 6 in (3.2 m) long. Various bomb racks were used to attach a variety of weapons. The main ejector rack was the Aero 7A-1 four-hook unit, with 30-in (0.762-m) lug spacing. This could mount the 2,000-lb Mk 84 bomb or AGM-12 Bullpup missile directly. For multiple bomb carriage a number of racks were available. The A/A37B-1 multiple bomb rack assembly and A/A37B-6 multiple ejector rack (MER) were used for up to six bombs of 250-lb (113-kg) weight, four in the 500-lb (227-kg) class or two in the 1,000-lb (454-kg) class. The A/A37B-5 triple ejector rack (TER) was useful for the carriage of rocket pods (usually LAU-10 four-round Zuni launchers) or for cluster bombs. Finally, the pylon could mount an A/A37B-3 practice multiple bomb rack (PMBR) which had six small racks for Mk 76 practice bomblets.

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Bullpup control
A feature introduced by the F-8E, which also appeared on the F-8H rebuild, was the fairing above the wing centre-section. This housed the AN/ARW-77 transmitter for the Bullpup missile. The system was used to transmit guidance commands by radio to the missile in flight. The missile was fitted with flares in the tail to allow the pilot to track it visually.

Performance and weights
The following figures for the F-8E were based on the carriage of four Sidewinders and 500 rounds of ammunition. Maximum speed in military thrust was given as 584 kt (672 mph; 1081 km/h) at 1,000 ft (305 m) and rate of climb in military thrust at sea level was 5,590 ft (1704 m) per minute. Service ceiling was set at 40,000 ft (12192 m), again in military power. Combat range was 1,238 nm (1,424 miles; 2292 km) and at a radius of 150 nm (173 miles; 278 km) from ship the F-8E could maintain a CAP station for 102 minutes. Empty weight of the F-8E was 17,836 lb (8090 kg), normal combat weight 30,232 lb (13713 kg) and maximum take-off weight was 34,100 lb (15468 kg), whether the aircraft was ship- or shore-launched. Maximum field landing weight was 26,000 lb (11794 kg), while for an arrested landing it was 22,000 lb (9979 kg).

Powerplant
All Crusaders were powered by Pratt & Whitney's excellent J57 turbojet. Originally dubbed 'Turbo Wasp', this engine ushered in a new era of jet design, using a two-spool configuration. The nine-stage low-pressure compressor was attached to the inner of the two concentric shafts, driven by a two-stage turbine, while the seven-stage high-pressure compressor was driven via the outer shaft by a single-stage turbine. In between turbines and compressor was the combustion chamber with eight interconnected flame tubes, with six fuel nozzles each. The various models of J57 used by the Crusader variants were as follows:

Variant	Engine	Thrust rating in afterburner
XF8U-1	J57-P-11	14,800 lb/65.86 kN
F-8A (early)	J57-P-12	16,000 lb/71.20 kN
F-8A (late), RF-8A, F-8B, F-8L	J57-P-4/4A	16,200 lb/72.09 kN
F-8C, F-8K	J57-P-16	16,900 lb/75.20 kN
F-8D, F-8E, F-8E(FN) (early), F-8H, F-8J (early)	J57-P-20/20A	18,000 lb/80.10 kN
TF-8A	J57-P-20	derated to 16,200 lb/72.09 kN
RF-8G (early)	J57-P-22	18,000 lb/80.10 kN
F-8J (late), RF-8G (late)	J57-P-420	19,600 lb/87.22 kN

The Dash 20 as installed in the F-8E was 22 ft 5½ in (6.85 m) long and 3 ft 4½ in (1.03 m) in diameter. The engine developed 9,150 lb (40.72 kN) thrust at normal rating and 10,700 lb (47.61 kN) at military rating. The engine was mounted on two main points: the front mounting was on the main wing rear spar/engine mounted bulkhead, the rear mounting was on the double frame rear fuselage break, the latter allowing the entire tail and rear fuselage to be removed for access to the engine. The afterburner incorporated a divergent/convergent variable nozzle which was enclosed completely within the outer skin of the airframe. This part of the rear fuselage was usually unpainted, but did not form part of the engine assembly. The hotter running temperatures of the Dash 16 and subsequent J57 variants required extra cooling for the afterburner area, resulting in the addition of cooling air scoops.

Wing pylons
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RF-8 details

Above: The Crusader cockpit was well laid-out for a 1950s jet, but was nevertheless complicated compared to today's fighters. Dominating the cockpit of the RF-8G was the circular lens for the downward-view periscope, which allowed the pilot to accurately control the vertical and forward-looking cameras.

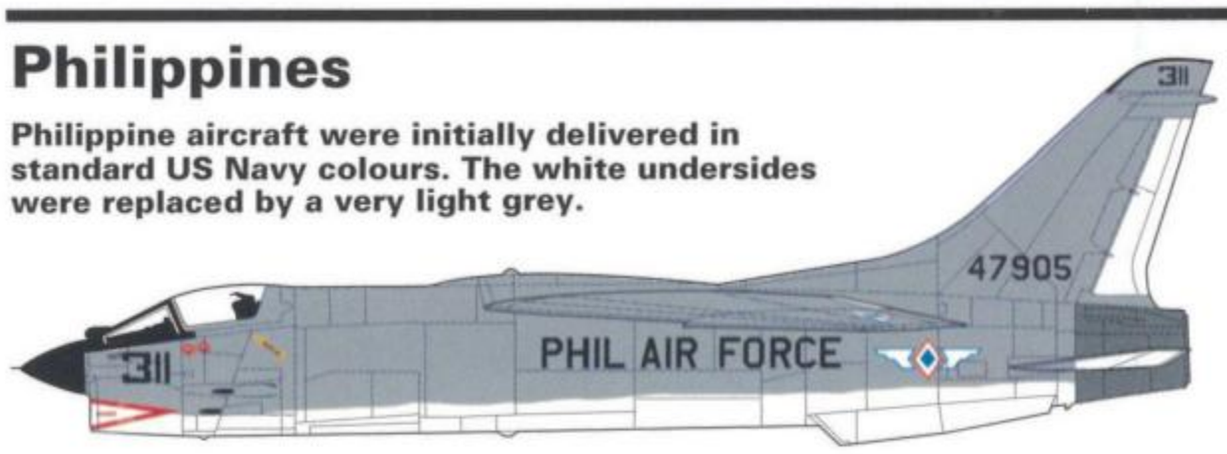
Right: This photograph of Glenn's Project Bullet aircraft displays the original camera window layout of the F8U-1P. The rear camera station could mount either vertical or sideways-looking cameras, and was used primarily to mount the three-camera trimetrogon horizon-to-horizon system prior to the more efficient single panoramic camera that was introduced. Note the small window for the pilot's periscope forward of the intake.

Above: Like most jets of its era, the Crusader had a detachable rear fuselage and tail unit to allow rapid access to the engine for maintenance or removal.

Right: The RF-8G had a retractable refuelling probe housed within the fuselage side. Note the pull-out lower access step and two drop-down foot/ handholds above it.

Philippines

Philippine aircraft were initially delivered in standard US Navy colours. The white undersides were replaced by a very light grey.



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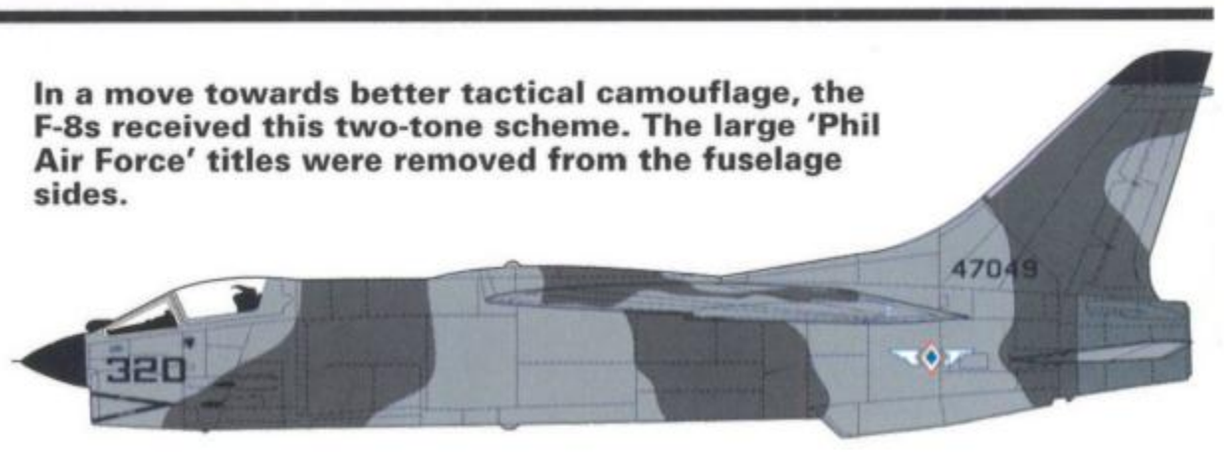

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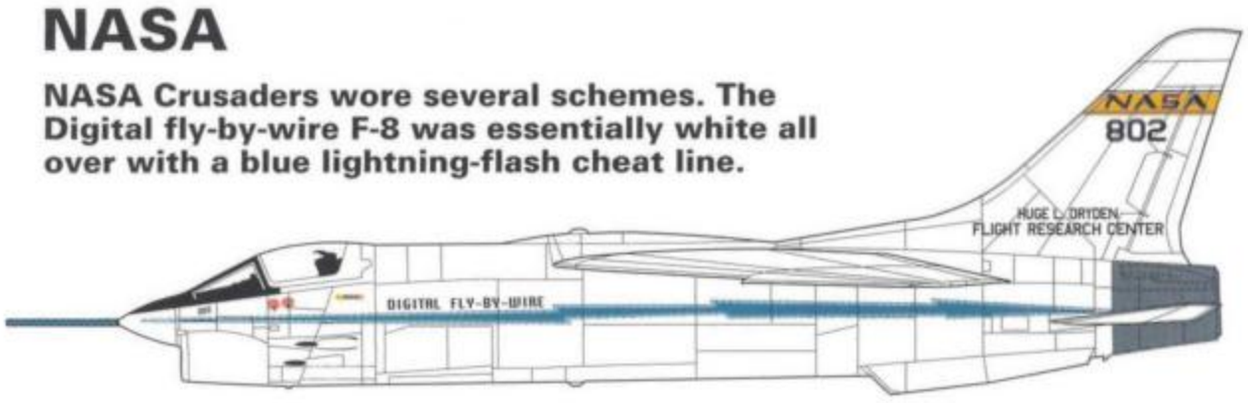

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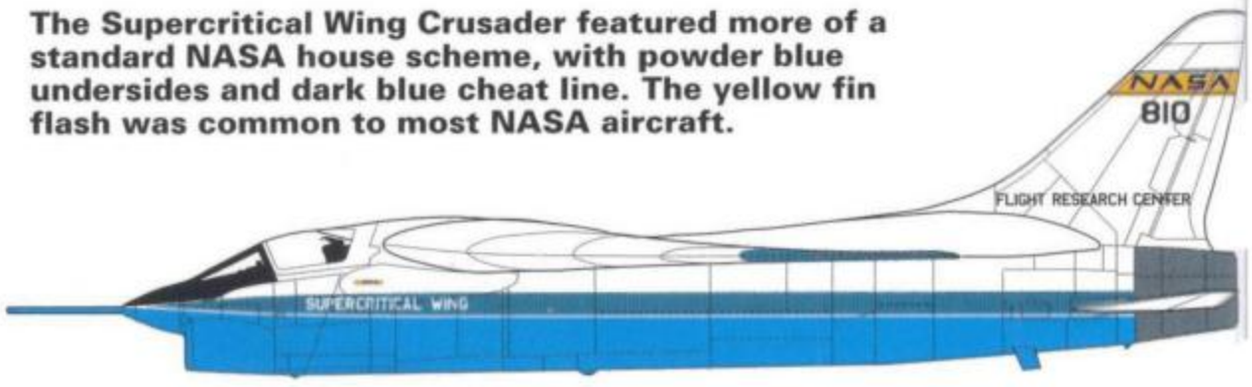


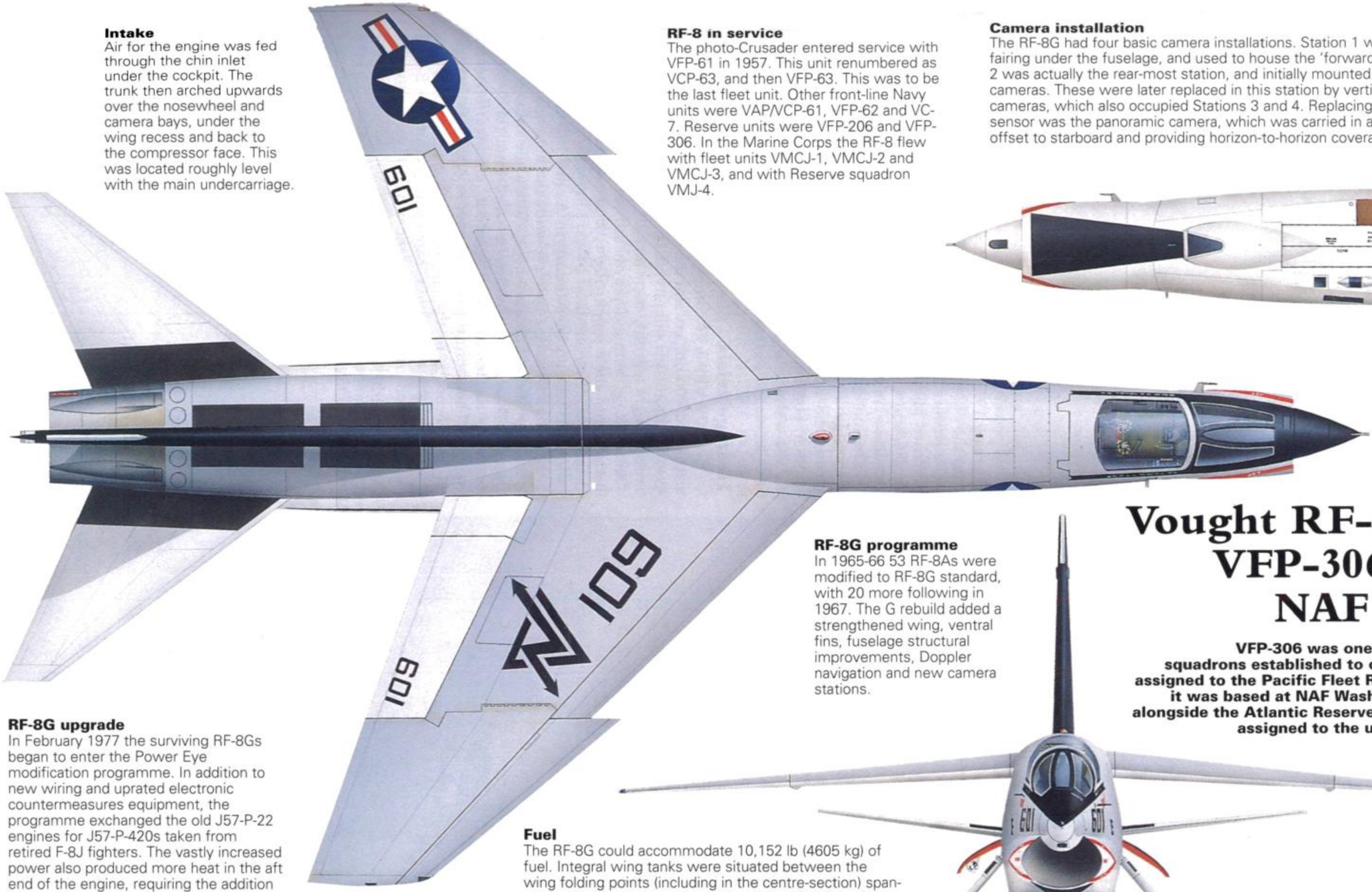
Vought RF-8G Crusader VFP-306, CVWR-30 NAF Washington

VFP-306 was one of two Navy Reserve light-photo squadrons established to operate the RF-8G in 1970. It was assigned to the Pacific Fleet Reserve carrier air wing, although it was based at NAF Washington (Andrews AFB, Maryland) alongside the Atlantic Reserve unit VFP-206. This machine was assigned to the unit's CO, Commander Tom Irwin.

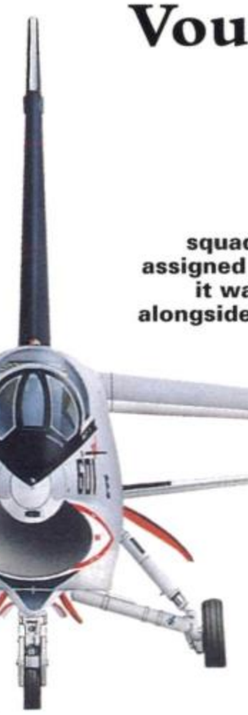
Intake
Air for the engine was fed through the chin inlet under the cockpit. The trunk then arched upwards over the nosewheel and camera bays, under the wing recess and back to the compressor face. This was located roughly level with the main undercarriage.

RF-8 in service
The photo-Crusader entered service with VFP-61 in 1957. This unit renumbered as VCP-63, and then VFP-63. This was to be the last fleet unit. Other front-line Navy units were VAP/VCP-61, VFP-62 and VC-7. Reserve units were VFP-206 and VFP-306. In the Marine Corps the RF-8 flew with fleet units VMCJ-1, VMCJ-2 and VMCJ-3, and with Reserve squadron VMJ-4.

Camera installation
The RF-8G had four basic camera installations. Station 1 was in the bulged fairing under the fuselage, and used to house the 'forward-fire' camera. Station 2 was actually the rear-most station, and initially mounted the trimetrogon cameras. These were later replaced in this station by vertical and oblique cameras, which also occupied Stations 3 and 4. Replacing the trimetrogon as a sensor was the panoramic camera, which was carried in a small angular fairing offset to starboard and providing horizon-to-horizon coverage.



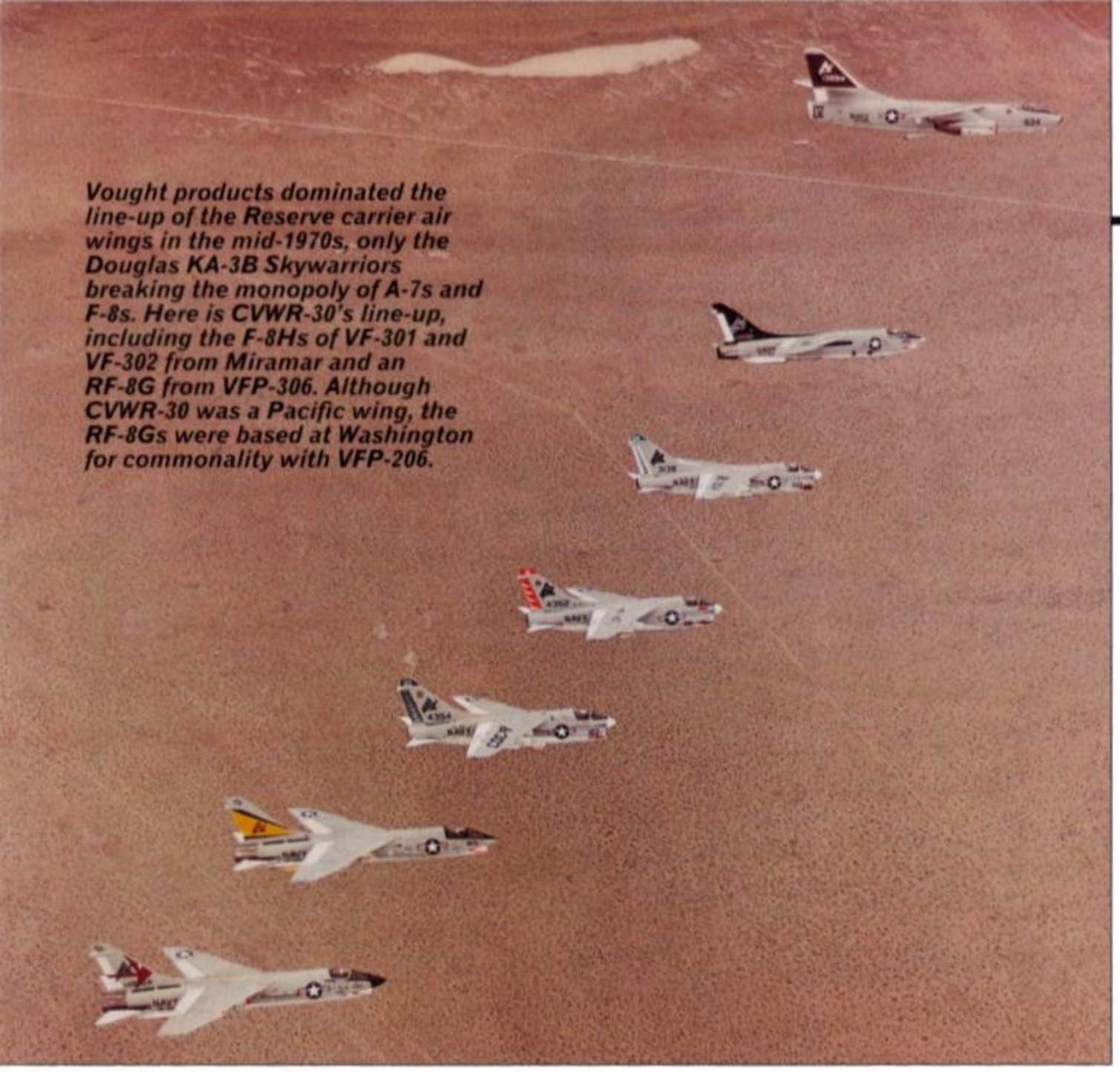
RF-8G programme
In 1965-66 53 RF-8As were modified to RF-8G standard, with 20 more following in 1967. The G rebuild added a strengthened wing, ventral fins, fuselage structural improvements, Doppler navigation and new camera stations.



RF-8G upgrade
In February 1977 the surviving RF-8Gs began to enter the Power Eye modification programme. In addition to new wiring and uprated electronic countermeasures equipment, the programme exchanged the old J57-P-22 engines for J57-P-420s taken from retired F-8J fighters. The vastly increased power also produced more heat in the aft end of the engine, requiring the addition of cooling airscoops either side of the upper jetpipe.

Fuel
The RF-8G could accommodate 10,152 lb (4605 kg) of fuel. Integral wing tanks were situated between the wing folding points (including in the centre-section) span-wise and the two main spars chordwise. Fuselage fuel was in a large tank which wrapped around the underneath of the air intake trunk aft of the camera bays and forward of the main wheel wells.

Markings
This RF-8G wears the standard US Navy gull grey/white scheme, with black anti-glare panel forward of the cockpit. The Modex number presentation was standard, but the 'ND' tailcode of CVWR-30 was considerably stylised on all of the wing's aircraft. In addition to the Battle 'E', the aircraft wears the squadron badge on the forward fuselage, this consisting of a jet aircraft flying over a strip of film, one frame of which depicts the Capitol Building.



Vought products dominated the line-up of the Reserve carrier air wings in the mid-1970s, only the Douglas KA-3B Skywarriors breaking the monopoly of A-7s and F-8s. Here is CVWR-30's line-up, including the F-8Hs of VF-301 and VF-302 from Miramar and an RF-8G from VFP-306. Although CVWR-30 was a Pacific wing, the RF-8Gs were based at Washington for commonality with VFP-206.

The forward-facing camera of the RF-8G allowed for some spectacular carrier approach photography. Here a VFP-206 aircraft heads for the deck of Saratoga.

Below: Shortly before the RF-8 retired, VFP-206 took the opportunity to fly with another Vought classic from an earlier era: the F4U Corsair.

The F-14 Tactical Airborne Reconnaissance Pod System (TARPS) was on the way, but it would have to overcome not only the normal introduction problems but also stiff resistance from the fighter crews in the Tomcat squadrons already in the fleet. No fighter pilot or RIO wanted to admit any interest in taking pictures, and no fighter skipper wanted to waste any of his valuable aircraft on special outfitting to carry and operate the expensive camera pod. It would take time for the F-14 TARPS to earn a place in the air wings of the 1980s. (In the mid-1990s, with a major war behind it, TARPS is, at best, a poor successor to the RF-8A/G. Many people were disappointed by its lacklustre performance during the 1991 Gulf War.)

Meanwhile, the RF-8G kept flying, assisted by modifications that included an engine change. With the release of many fighter engines, the Navy planned to replace the J57-P-22 engines of the remaining photo-birds with the more powerful J57-P-420 engine of the J model. Begun in February 1977 and called the Power Eye Mod, this upgrade gave the old RF-8Gs nearly one-third more power, and the old airframes literally leapt off the runways, much to their surprised pilots' delight. In addition to the engine change, modifications also included new electrical wiring and the installation of new ECM equipment.

The modified RF-8s could be readily identified by the two large air intakes mounted on their tailcones. The change did not mean just replacing one powerplant with another, but required reams of instructions and lists of parts for the wiring, clamps and monitoring devices for the actual installation and operation of the P-420.

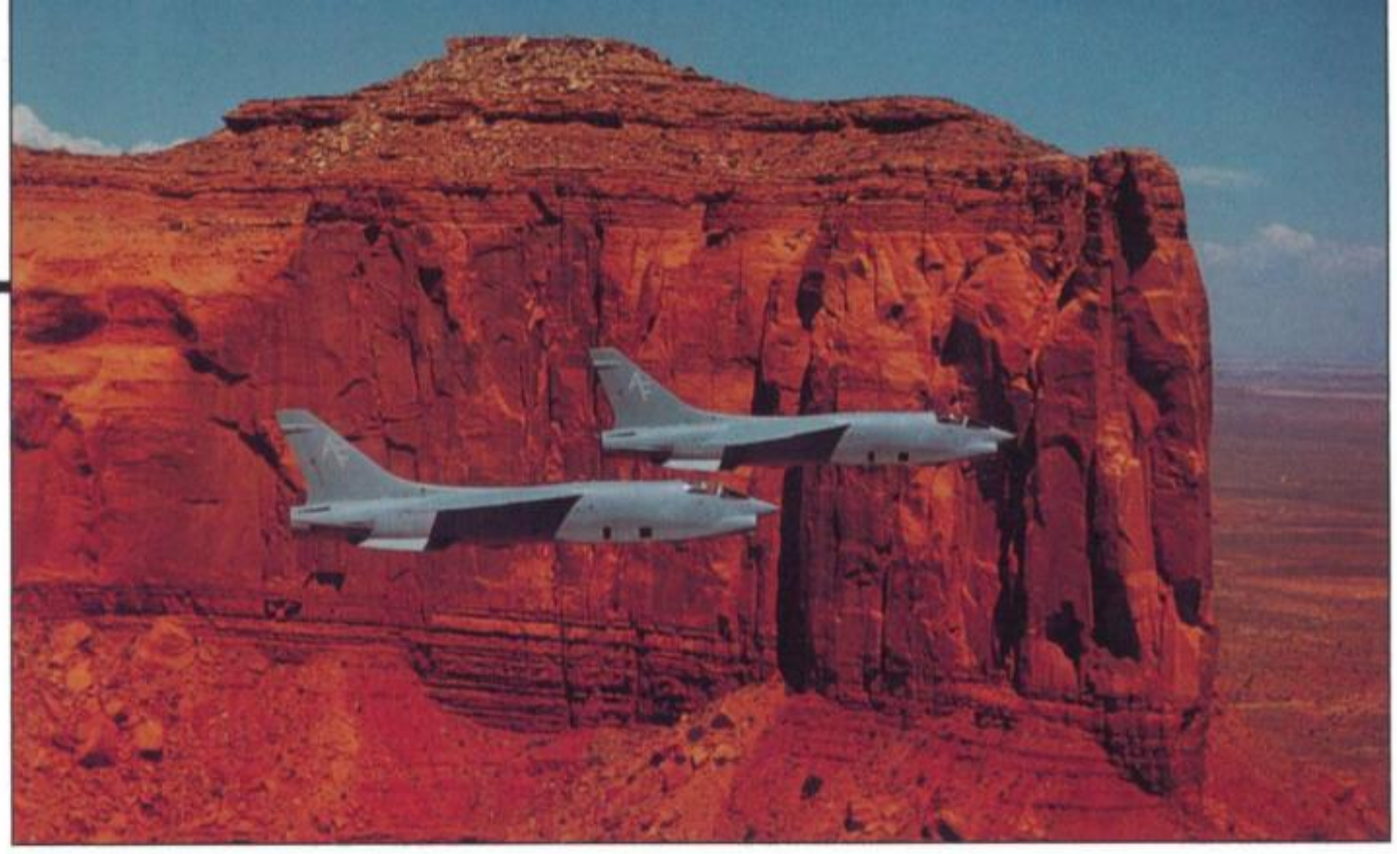
Hostage crisis

By 1979 VFP-63's complement, which at one time had numbered 700 officers and men, had been reduced to 300. But the photo dets still served. In 1979, the Iranian hostage crisis brought a greatly increased US presence in the Indian Ocean. Long, boring deployments were the norm, and the carriers and their supporting task forces settled into one dreary cruise after another.

VFP-63's Det 5 left Miramar in August 1979 before the crisis. They flew east to serve with the air wing of new nuclear-powered carrier *Nimitz*. When the hostage crisis began in November, the *Nimitz* sailed from the Mediterranean to the Indian Ocean where it remained for several months. The abortive rescue attempt in April 1980 brought H-53 helicopters to the *Nimitz*. Det 5 gave up its spaces, including the ready room it shared with the carrier's EA-6B squadron, and cross-decked to the smaller *Coral Sea* to serve alongside that ship's own Det 2, which had left Miramar in November. The two dets remained with the *Coral Sea* until its return to the States in June 1980. What had begun as a six-month cruise for Det 5 became a 325-day, two-ship deployment which took the members around the world.

Eventually, the date was set for the last RF-8 cruise and

Right: An RF-8G vents fuel to get down to landing weight prior to trapping. VFP-306 was the first of the two Reserve RF-8 units to go, in 1984, followed 2½ years later by VFP-206.



Above: Seen in April 1985, a pair of VFP-206 RF-8Gs transits through Monument Valley en route to Fallon. With its newly-acquired low-visibility paint scheme, the Crusader still looked every inch a potent warplane even in the twilight of its Navy career.

Far left: Like its 1960s USAF equivalent, the RF-101 Voodoo, the RF-8 photo-bird was designed with high speed as the principal defence. Several sacrifices of the fighter's manoeuvrability were made to achieve this, and horsing around the sky in an RF-8G was not as easy as it looked. The Power Eye engine upgrade certainly helped.

the retirement of the fleet's last Crusader squadron. Again, the *Coral Sea* figured in Crusader history as Det 2 sailed with Air Wing 14 for an Indian Ocean deployment. On 22 March 1982 the carrier and its photo detachment arrived home, where RF-8G BuNo. 144618 landed at Miramar to formally end the cruise, and the last regular deployment of a Crusader squadron. In January the squadron had received notification that 30 June would be its last day. Even before the ceremony, the last fleet RF-8G flew to Davis-Monthan on 28 May. Included in Det 2's final cruise was the last Crusader 'nugget', first-tour aviator Lieutenant John DuGene, who in 1980 had been the last RF-8G fleet replacement pilot to be trained in the Crusader.

He commented, "I'm part of the history of a great aircraft. The RF-8 is a fun aircraft to fly. It creates a sense of responsibility and confidence." During the cruise DuGene, who would soon transition to the F-14, flew an aircraft older than he: BuNo. 144607 was then the oldest supersonic aircraft serving in the Navy and had been built in 1956, several months before DuGene's birthday.

Part of the VFP-63 retirement ceremony including passing the famous Crusader Sword. Purchased in March 1967 by then-Lieutenant Commander Bruce Moorehouse of VF-124, the 13th century weapon had actually belonged to a real crusader. Leaving VF-124, Moorehouse decided Crusader College needed something more fitting than another ugly trophy. A New York antique dealer found the sword, and soon VF-124 had one of the most appropriate symbols of any military squadron. The sword even came with a motto: 'Draw Me Not Without Reason, Sheathe Me Not Without Honour'.

The sword remained with VF-124, then with VFP-63. In June 1982, with the disestablishment of VFP-63, the Washington reserve squadrons VFP-206 and VFP-306 assumed joint custody of the priceless relic.

After 33 years of providing photo-reconnaissance to the Navy, VFP-63 retired, the last dedicated photo-reconnaissance squadron flying the last dedicated reconnaissance aircraft in the Navy: the RF-8G Crusader. Commander David M. Beam, the last skipper of the 'Eyes of the Fleet', declared, "It seems like I've been here forever. I came as a nugget in 1966 and now I'm here closing the door." But the Crusader still had a few good years left in it, and had been busy carving another career in the reserves.

Four VFP-306 skippers stand with the Crusader Sword during the squadron's decommissioning ceremony in September 1984. From left to right are Capt. R. F. Norrell (1979-81), Capt. T. C. Irwin (1977-79), Capt. R. G. Hoch (1975-77) and Cdr A. E. Wattay (1973-75). The 12th century sword was previously owned by VFP-63.

A second life: the Reserves, 1965-1987

In January 1968 the North Koreans captured the US intelligence ship *Pueblo* and imprisoned its crew. Part of the Navy's response was to mobilise six Reserve squadrons, including three F-8 squadrons: VF-703 in Dallas, VF-661 at Andrews near Washington, DC, and VF-931 at Willow Grove, near Philadelphia. The F-8A and B Crusader had been serving with the Reserves since 1965. Originally, the squadrons shared the aircraft and flight time between the Navy and Marine Air Reservists, who operated at the same bases. The aircraft, in fact, carried a joint NAVY/MARINE marking on their fuselages.

The 1968 recall was a disaster. VF-931 and VF-661 went to Cecil Field in Florida, while VF-703 travelled to Mira-

Final Navy sortie

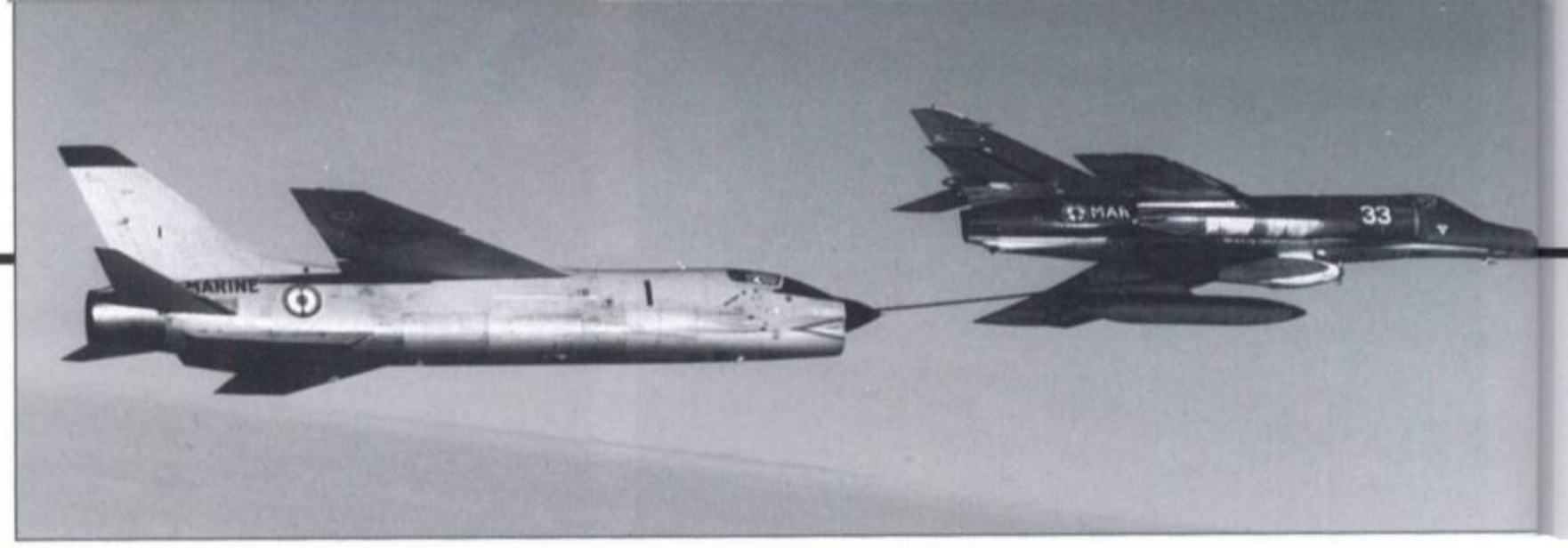
Navy operations of the F-8 came to an end over a weekend of mixed emotions in March 1987. The final flight, made on the Monday morning, was from NAF Washington to Dulles International Airport.

Ten days before the final flight, Lieutenant Commander John Cotton flew the last operational sortie of a USN Crusader, on 20 March 1987. Here Cotton unfolds AF 703's wings prior to the flight.

Left: Commander Dave Strong prepares to start his RF-8G for the Crusader's last US Navy flight, on 30 March 1987.

F-8E(FN)

France purchased 42 Crusaders based on the F-8E to revamp its carrier forces, but to accommodate them on the two small carriers the design was reworked with a 'blown' wing to dramatically reduce approach speed. Over 30 years later the survivors still form the Aéronavale's front-line fighter force.



Above: The first F-8E(FN) is seen refuelling from a buddy-pod equipped Super Etendard.

Right: Two French Crusaders overfly the Brittany coast near their shore base at Landivisiau. Two squadrons were formed, assigned to the two carriers.

Lieutenant (later Rear Admiral) James Flatley prepares to fly the second F-8E(FN) during initial carrier qualification trials aboard Shangri-la in 1964. After these had been completed, both Vought and US Navy personnel were dispatched to France to oversee the Crusader's entry into service. The 'FN' in the designation stood simply for 'French Navy'.

mar to transition to the latest fleet versions of the F-8, the C and E models. The problems encountered in training, maintenance and availability were so great that by November the units still were not operational. The ultimate resolution of the *Pueblo* Crisis allowed the deactivation of the Reserve squadrons, and gave the Navy much to consider.

By 1970, the Reserves had been reorganised to mirror the fleet. The far-flung squadrons were re-established as members of two Reserve carrier air wings, CVWR-20 and CVWR-30, which would mobilise with the Atlantic and Pacific Fleets, respectively. In addition to the administrative reorganisation, the new squadrons also received fleet-comparable aircraft. Each CVWR included two fighter, three attack, one early warning, one tanker and one light-photo squadrons. At the time, the Crusader equipped three of the squadrons, the fighter and light-photo. Eventually, the A-4s in the three light attack units were replaced by A-7A and B Corsair IIs, creating a nearly all-Vought air wing.

Naval fighter reserve

VF-201 and VF-202 in Dallas, Texas, and VF-301 and VF-302 at Miramar flew the F-8H and later the F-8J, while VFP-206 and VFP-306, both located at NAF Washington, DC on Andrews AFB, flew RF-8Gs. Even VC-13, a composite squadron, received F-8Hs when it was formed on 1 September 1973 at New Orleans. (The 'Saints' exchanged their H models for A-4Ls in April 1974.) In the middle of the Vietnam period, all air reserves boasted a high level of combat-experienced pilots, and it showed. Reserve aviators continuously demonstrated their proficiency, whether operating around carriers or in bombing and fighter competitions.

VF-201 and VF-202 quickly qualified their pilots with CQs (carrier qualification periods) on the super carrier USS *John F. Kennedy* in 1971. VFP-206 and VFP-306 conducted their initial CQs on the USS *Franklin D. Roosevelt*. The two reserve VFP squadrons also made generous use of the facilities at Miramar which, besides their own small lab at Andrews, was the only base that could support the photo mission with proper film processors. The fighter squadrons differed from the light-photo squadrons, not only in models of the F-8 and mission flown, but in actual size, number of aircraft and personnel complement. Whereas the fighter squadrons might include 10-15 Reservist pilots, with perhaps 100-150 maintenance, administrative and support troops, the VFP squadrons were essentially detachments with no more than five aircraft, and perhaps 50-60 people including six or seven pilots. The smaller size of the VFPs made for an increased workload for the squadron members, which highlighted the dedication needed to be a naval air reservist.

By 1975, the F-8Js had also retired. In that year both the Naval and Marine Air Reserves transitioned to F-4B Phantoms, leaving only the photo Crusaders. Onboard *Ranger*, the F-4s of VF-301 and VF-302 flew CAP and escort missions. The black-tailed RF-8s of VFP-306 earned high marks for their performance. The test was a resounding success and silenced critics, but only for a while.

Throughout the late 1970s and early 1980s, the RF-8Gs continued flying. The draw to fly the Crusader brought many young aviators, fresh from the fleet, to Andrews. They waited for months for a chance to fly the legendary F-8, even the non-fighter reconnaissance version. With the Power I Mod, the old jet's performance was impressive, and even the most jaded youngster who just left an F-14 cockpit had his enthusiasm rekindled after his first flight in the Crusader. During a 1978 CQ on the *Kennedy*, Lieutenant Commander Eliot Tozer, who had recently joined VFP-306 and made his first carrier landings in the Crusader, entered the squadron ready room, his flight gear still buttoned and zipped and his face aglow. "Damn, I got all my traps. I'm a qualified F-8 driver!" Although he was an experienced A-4 pilot with many combat missions in Vietnam under his belt, it had always been Tozer's dream to fly the F-8, and he had finally realised it.

The Marine Corps Air Reserve included several Crusader squadrons that became the prime operators of the K and L models, except for a few of these conversions which flew with fleet VC squadrons for a short time. These models retained the F-8E's ground-attack capability, which was at the heart of all Marine aviation, supporting the troops on the ground.

VMFA-112 at NAS Dallas and VMFA-321 at NAF Washington operated much the same as their Navy sister squadrons, usually at the same fields. Rather than Fallon, the Marines took their active-duty training at the desert air

A single F-8E(FN) escorts Super Etendard attack aircraft on a low-level training mission. As France's maritime commitments dwindled, and as Crusader losses mounted, one of the squadrons was disbanded, leaving 12F to fly the surviving aircraft.

station at Yuma, Arizona, in the southwestern corner of the state. The weapons ranges and good flying weather were perfect. Along with the Navy, the Marines traded in their F-8s for Phantoms, in 1975.

The last squadron

Continuing to provide the Naval Air Reserve with modern equipment, the Navy transitioned the four Reserve fighter squadrons to the F-14 Tomcat. VF-301 and VF-302 were chosen to be the first to change, with 302 taking over TARPS duties; 201 and 202 would transition later, with 202 becoming the TARPS squadron for CVWR-20. As the plans solidified, so did the date for the decommissioning of VFP-306. On 30 September 1984, Commander Gary W. Riese, the last of VFP-306's seven commanding officers, ordered his squadron's colours struck as hundreds of observers, officials and squadron alumni watched.

The 'Hawkeyes' of VFP-206 were now the sole remaining US Navy Crusader squadron. For the next 2½ years, VFP-206 flew its RF-8Gs all over the country, and conducted CQs, all business as usual, even though the writing was on the wall. Its disestablishment was coming: March 1987. In October 1986, the 'Hawkeyes' joined other fleet and Reserve squadrons for a CQ on the USS *America*. Coincidentally, it would also be the last CQ for the F-4, with VF-201 and VF-202 making their final traps before transitioning to the F-14.

On 18 October Lieutenant Commander Barry D. Gabler manned RF-8G BuNo. 145633 and launched. "A good run-up, a quick check of my instruments, a salute, and then the massive acceleration of the cat. We were airborne and climbing out in full afterburner. No. 145633 and I did one roll and joined up with the flight for a diamond fly-by. For both of us, it was the end of our carrier careers."

The last weekend

On 29 March 1987 the last Crusader squadron retired, along with the last US RF-8. BuNo. 146860 had been built as an F8U-1P (RF-8A) in 1959, and served with Marine squadrons VMCJ-1 and VMCJ-3. Later, assigned to VFP-63's Det 19 in the *Hancock* in 1970-71, it accumulated 200 hours in combat. Stored at Davis-Monthan in June 1971, it was later reassigned to VFP-206 in 1973. As AF 701, this veteran Crusader served as a focal point during a weekend of memories.

Displayed with 'One-X', the first XF8U-1, BuNo. 138899, loaned by the Smithsonian Air and Space Museum, 860 provided a backdrop for one more picture for the many F-8 alumni, pilots and ground personnel. Retrieved from years of storage, 'One-X' was lovingly restored by the members of VFP-206, repainted and polished so it gleamed in the sunshine that graced the final milestone in the Crusader's US Navy career.

Commander David Strong, the last of VFP-206's 10 commanding officers, and the last Crusader CO, held the somewhat dubious honour of making the final ejection from a US Crusader, in 1985, for which he received a rare peacetime Distinguished Flying Cross from the Secretary of the Navy (this event is described on page 86). On Monday 30 March, Commander Strong made the last take-off in the last Crusader. This time, the weather did not co-operate and the clouds were thick and low. Undaunted, Strong made three low, fast passes over the naval air facility then stood his aircraft on its tail and rocketed up into the clouds. It was a fitting end to the Crusader's career after so many years, when as many as 71 Navy and Marine Corps squadrons flew the Crusader, an incredible number considering that only 1,261 Crusaders were built. The last Crusader's last flight lasted only 20 minutes as Commander Strong brought it to the Smithsonian's storage park at Dulles International Airport in Virginia to await restoration and display at a future date.

Reserve Captain (later Rear Admiral) Tom Irwin, himself a 2,800-hour F-8 pilot who participated in some of the first combat missions over North Vietnam in 1965, and a former commanding officer of VFP-306, wrote a fitting epitaph for the Crusader in the July 1982 issue of *Naval Aviation News*. "Its record of achievement will never be diminished as it moves from active service into retirement. It will always be the aircraft that moved naval aviation to the forefront of supersonic tactical flight. Those who flew the Crusader, loved it. Those who didn't, respected it."

Above: Caught in classic cat-shot pose, a clean F-8E(FN) launches. French aircraft have not been involved in any direct actions, but did cover Super Etendard raids into Lebanon in 1983. More recently the type has been active over the Adriatic in connection with the UN/NATO operations in the former Yugoslavia.

Left: The graceful lines of the Crusader are shown to advantage in this unusual view of an F-8E(FN). The aircraft is carrying a single training round of the MATRA R.550 Magic missile, identified by its characteristic double forward fin group.

The Crusader in foreign service

Besides the F-4 Phantom and the Bell H-1 series of helicopters, no American combat aircraft of the immediate post-Korean period had as long, though geographically limited, a foreign career as Vought's F-8 Crusader. The Crusader has enjoyed as long a career with France's Aéronavale as with the US Navy. This success is all the more remarkable since only 42 F-8s entered French service. Even today, although the American Crusader is gone, the French fighter continues to serve into the late 1990s. The

Crusader nosewheels received considerable punishment during deck operations. This F-8E(FN) carries a MATRA R.530 missile, this weapon providing a radar-guided alternative to the heat-seeking Magic or Sidewinder. The R.530 also had an infra-red seeker option.

Another long-suffering nosewheel receives a hefty thump as this 12F Crusader lands aboard Clemenceau. The addition of BLC to the F-8E(FN) was accompanied by a slight reduction in wing incidence travel.

With flaps down and tailplanes up, a French Crusader rides the cat. The French aircraft have been rewinged (with low-time F-8J wings) and have recently undergone a limited upgrade programme, resulting in the F-8P (for prolonge) designation.

Right: The slate-grey camouflage was introduced in the mid-1980s, proving more effective over the dull waters of the North Atlantic than the earlier light grey. Crusaders will remain in service with 12F until about 2000.

French had been impressed by the TF-8A's performance at the 1962 Paris air show. The 'Two-sader' had been on a road trip to drum up business for Vought's pacesetter. At one point, the British showed strong interest in the two-seater, which offered supersonic performance ashore and onboard carriers, as well as the opportunity to train pilots and navigators in an advanced aircraft. However, the British ultimately chose the more expensive Phantom since it offered better long-range interception capability for the fleet defence role and carried more ordnance in the attack role.

The French wanted a replacement for the ageing first-generation jets that flew from their two new carriers, *Foch* and *Clemenceau*, generally comparable to the US '27C'-class aircraft-carriers, but the Crusader's high approach speed gave cause for concern in operating from the small French decks. Vought agreed to extensively rework the F-8's wing and to incorporate boundary layer control, which blew hot engine air over the wing-control surface, creating more lift and thus reducing the approach and stall speeds. The horizontal tail was also enlarged for better stability. The stall speed dropped from 113 to 90 kt. An F-8D, BuNo. 147036, was used for the test airframe and flew in February 1964; although it crashed in April, the first production F-8E(FN) flew that June. The production run was completed in January 1965. Originally, 46 single-seaters and six two-seaters had been ordered, but when the development of the 'Two-sader' was cut short, the French reduced their order.

After initial carrier qualifications on board *Shangri-la*, with US Navy pilots coaching French aviators, a group of Vought and US Navy pilots went to France for one year's duty to help the French transition. In May 1965, the first CQs on board a French carrier had been conducted. Although the F-8E(FN) retained the US armament of four 20-mm cannon, the external missile load was altered to accommodate French missiles, primarily the MATRA R.530 and R.550 air-to-air missiles. Sidewinders could be carried, but the MATRA was the first choice.

F-8E(FN) in service

Two *flottilles de chasse*, roughly equivalent to fighter squadrons, were equipped with the F-8. 12F and 14F had flown another Vought product, the F4U-7 Corsair, in then-Indochina from the carrier *Lafayette* in 1952-53, in the 1956 Suez Crisis from the *Arromanches*, and finally, during the 1961 Algerian crisis, from shore bases. 12F had been decommissioned in 1963 and 14F in 1964, but they were recommissioned in October 1964 and March 1965, respectively, on the Crusader. French pilots took enthusiastically to their new mounts. By 1970, 12F and 14F had each logged more than 20,000 hours in their F-8s. Premier Master Pilot Roland Peltre became the first 1,000-hour Aéronavale pilot in 1969, and was duly awarded an aircraft tyre around his neck. In a more serious vein, Peltre said, "I consider the Crusader an excellent fighter and one that brings much satisfaction to its pilot." 14F eventually transitioned to the Super Etendard in May 1979, its F-8s going into storage to be used by the remaining Crusader squadron.

The F-8s not in service were placed in huge plastic bags at the large base at Landivisiau, near Brest on the English Channel. Only half of the original F-8E(FN)s survive, with 14 in service in detachments assigned to the two French carriers. Although the French Crusader's original colours and markings were fairly reserved, the American grey-and-white scheme gave way in the twilight of the French fighter's career to a menacingly striking slate blue-grey. The F-8E(FN)s were also retrofitted with F-8J wings.

The only combat service the F-8(FN)s saw was during the tense period in September 1983 in the Eastern Mediterranean. *Foch* arrived off Lebanon on 6 September, and on 22 September French Crusaders from *Foch* flew CAP for a Super Etendard strike force that hit rebel gun positions in Lebanon. The French seemed reluctant to publicise the American aircraft's role, and only covertly mentioned F-8s in newspaper stories, simply stating the Crusaders "were charged with protecting the bombers," the Super Etendards. The *Foch*'s air group transferred to *Clemenceau* when that ship relieved *Foch* in early October. Several reconnaissance missions were flown, along with a relatively unproductive reprisal raid by 14 Super Etendards on 17 November. It might be assumed that this raid was covered by an F-8 CAP. During the Gulf War, French F-8s were held in reserve, their carriers being used to transport helicopters and material.

In early 1988, a French team visited Davis-Monthan AFB in Arizona to inspect stored F-8s. They took parts from several F-8Js, and after a major rework, including strengthening the wings, new electrical harnesses, upgraded ejection seats and various avionics upgrades, the refurbished F-8E(FN)s were redesignated F-8Ps (*prolonge*). The 17 F-8Ps will serve with 12F for another three to five years, by which time the long-awaited Rafale will enter service.

Of the original 42 F-8E(FN)s, the Aéronavale has lost 25, including four airframes struck because of crash damage. There have been six fatalities, including one fatal on ejection. The French have had 15 ejections from F-8s. The

first loss came on 28 September 1965 (aircraft 28) and the first fatality occurred on 24 July 1968 (aircraft 21). At the time of writing, the most recent losses were aircraft 31 on 20 September 1995 and aircraft 27 on 30 September 1995.

Crusaders in the Philippines

In late 1977, the Philippine government purchased 35 F-8Hs, 25 of which were to be completely refurbished by Vought and the remaining 10 to serve as replacement aircraft. The Crusaders had been in storage at Davis-Monthan. The aircraft were sold for $11.7 million, with an additional contract for $23 million to cover the refurbishment by Vought and training of Philippine air force pilots and maintenance personnel. As noted earlier, the two-seat TF-8A had been used to indoctrinate the PAF pilots but was lost on 28 July 1978, when the Vought pilot and his Filipino student ejected, and the TF-8A crashed in a farmer's field. Although the Philippine government had really wanted F-15s or F-16s, the 'sale' price of the F-8Hs was too good to pass up. The aircraft went to the PAF's 7th Tactical Fighter Squadron, 5th Fighter Wing at Basa Air Base, Pampanga, in northern Luzon. The 7th TFS had been established in October 1957, flying F-86F Sabrejets.

Vought sent a training and administrative team which

Above: During their heyday in the early 1980s, the Philippine F-8s were well-flown and well-maintained. By 1984, when Vought personnel were dispatched to refurbish the survivors, many were showing the signs of tropical corrosion.

Left: Philippine technicians make last-minute checks to the first F-8H reworked by Vought for the PAF. The aircraft left Dallas for its new home on 31 May 1978. The Vought contract included a one-year training programme and a 10-year field support and spare parts package.

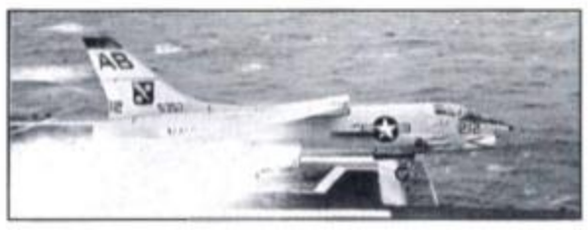
Above: Badge of the 7th Fighter Squadron, PAF.

Below: By the early 1990s some PAF F-8Hs were still in existence, but largely derelict.

Philippine Crusaders

The Philippines air force was an unlikely customer for the Crusader, but the aircraft were offered at a bargain price. The 25 operational F-8Hs were drawn from surplus US Navy stocks in 1977 and thoroughly refurbished by Vought prior to delivery.

Successful ejection



In October 1961 VF-11's Lt(jg) John Kryway had the Roosevelt's deck drop out from under him, causing him to land hard, breaking the starboard undercarriage and starting a magnesium fire. He ejected safely as he went over the angled deck.

remained in the Philippines for a year to help the Filipinos become self-sustaining, particularly in the maintenance area. Initial attempts to change engines were not very successful, but eventually the Filipinos became fairly proficient in maintaining and flying their new aircraft. They participated in the US Air Force's Cope Thunder exercises, earning high praise from American officials.

In March 1984, Vought sent a contingent to help the Philippine air force refurbish their 19 remaining F-8Hs. The Crusaders had begun to show drastic deterioration in the humid Philippine environment. For the next year, the Americans helped the Filipinos patch up their F-8s. The Metallite had actually begun to disintegrate and the Vought team glued together several layers of local plywood, covered them with aluminium, and fitted the pieces to the area on specific airframes. Finally, only 12 F-8s remained, with the other seven being cannibalised for parts. Of the 12 Crusaders remaining in service with the PAF, only eight were fully mission-capable at any one time.

During the removal of Philippine President Marcos in 1986, the Crusaders were flown to the US Air Force base at Clark near Manila to protect them from saboteurs. The F-8s were intended for air defence and ground attack duties, but they also stand alert duties alongside the PAF's F-5s. By 1991, age, weather and climate – not the least of which was the eruption of Mt Pinatubo, which rained volcanic ash all over the Philippines – had taken their toll on the PAF's Crusaders, and those that remained were retired.

Nylon letdowns: when your landings don't equal your take-offs

By the time the Crusader retired, US Navy pilots had made 493 ejections from all models of the F-8. Overall, 517 of the 1,261 Crusader built had been lost, a loss rate of 41 per cent. Eighty-four Crusaders had been lost in Vietnam as a result of flak, SAMs and small arms, plus three or four to MiGs. There was a period when at least one ejection from an F-8 occurred each month, from June 1957 to February 1969, with a break for March, then beginning again in April 1969 until May 1970. As the Crusader began leaving the fleet, the pace accelerated as the Reserves picked up more F-8s.

VFP-63 had 15 ejections from October 1973 to July 1981, and was the front-runner, with 60 ejections, followed by VF-124 with 42. VF-194 totalled 31 bailouts, VF-211 had 22, and VF-162 had 21, just to name a few. The numbers and comparison lists could go on and on.

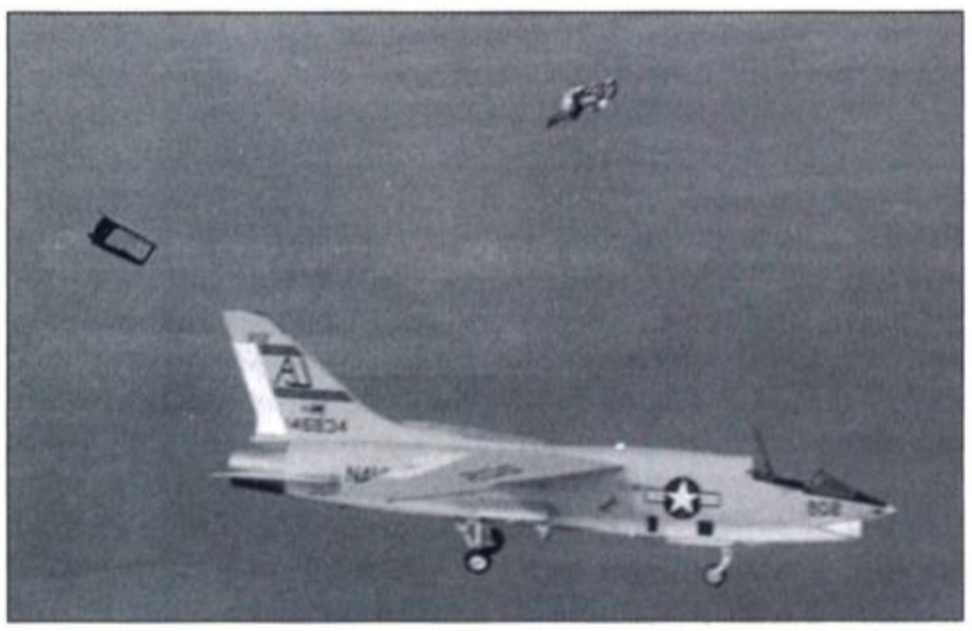
Thirty F-8 pilots were double winners, making two ejections, and four individuals liked it so much they opted for a third rocket ride. Of course, many of these emergency egresses were in combat and the choice was limited: stay and die, or eject and survive, even if it meant as a POW. Lieutenant (jg) Rick Adams and Lieutenant Commander Butch Verich of VF-162 ejected twice in combat. VF-211's Lieutenant Gene Chancy ejected once in 1963, and once more in 1966 a month before scoring his MiG kill. The second bailout occurred when he was shot down by flak during a strafing run.

The first ejections from an F-8 occurred in 1956. During an evaluation flight, Marine Captain James Feliton punched out on 4 May. Veteran test pilot John Konrad, the first man to fly the F-8 in March 1955, was forced to eject when his aircraft's engine failed at high altitude on 14 August. Bob Rostine, another Vought test pilot, left his F8U-2NE prototype later in the year.

The first fleet ejection came on 30 January 1957, when Captain Bob Dose of VX-3 had his engine come apart at 10,000 ft (3048 m). After trying six times to restart his engine, Dose ejected, to be rescued from the chilly Atlantic by an Air Force amphibian. It was only the beginning.

From 1957-1960, F8U-1s dropped from the air with frightening and frustrating regularity. The first F8U-1P ejection came on 24 July 1958, when a VFP-63 aviator left his aircraft. Every unit recorded at least one punch-out, whether it was a fleet squadron, Navy or Marine, or a specific facility such as the Naval Air Test Center at Patuxent River or a naval air rework facility. VF, VFP, VMF, VMCJ or VC, it made no difference. The F-8 played no favourites. And once Vietnam got rolling, well . . .

Zero-zero ejection capability did not arrive until the mid-1960s, and out-of-the-envelope ejections were not advised. Lieutenant (jg) Tom Irwin had to decide to stay



Another well-publicised ejection was made by this VFP-62 pilot, seen leaving his RF-8A. The canopy was ejecr st before the seat ' The extendir up which the ' ravels is clearly v' . This was directl' ne with the seat ' , with the co' uence that there ' ew spinal injuries sed by ejection.

Failed barrier engagement

This sequence depicts the last moments of a VF-191 F8U-1. Although the Crusader appears to take the barrier successfully, the aircraft punches through before slithering over the deck edge, watched by the helpless hook runner.

and ditch in his doomed F-8 in 1965. On 13 January Irwin returned from a daytime air-intercept training mission. VF-24 was part of *Hancock*'s CVW-21 off Vietnam but the war had been quiet. Irwin snagged the carrier's 4-wire, and the roll-out seemed normal. He was about to retard the throttle when he suddenly realised he was not stopping. The F-8C, BuNo. 147011, was headed for the edge. Irwin had to consider the two-second delay between selection and 'burner light.

The young aviator could not know that his hook point had sheared from the shank. He selected 'burner, but the Crusader floated over the angle and the indicated airspeed was below the 80 kt (148 km/h) needed for a successful ejection. Irwin pulled the canopy jettison handle but, although the latches released, there was not enough airflow to carry the canopy away, and it stayed on the doomed fighter. In the limited time remaining, he considered an out-of-the-envelope ejection but decided to stay with the aircraft. He had enough airspeed for limited pitch control, at least until his main wheels rolled over the deck edge. By using the rudder to keep his wings level, he was able to enter the water more or less level, rather than nose first or in a cartwheel.

As the F-8 hit the water, the afterburner ignited, causing the engine to explode. The splash also carried away the canopy. Although the Crusader entered the water upright, water immediately began pouring over the cockpit sill. Irwin pulled the ditching handle, which released him from the seat, and he bobbed out of the cockpit just as a wave splashed over him. The oxygen hose from the seat pan to his mask was entangled on the canopy handle on the right canopy rail. While awash and laying on the rail, Lieutenant (jg) Irwin separated the connector at the end of the mask hose and quickly rolled over the side of his fighter. The forward end of the centre section of the Crusader's two-position wing, and most of the vertical stabiliser, were all that were above the water.

Having inflated his life preserver, Irwin swam away as his Crusader finally sank out of sight. The *Hancock* had stopped close to his position and the ship's H-2 helicopter plucked him from the South China Sea. The time from the deck to the water was two seconds; from the water to the flight deck, safe and sound, was two minutes. He noted later, "I was never able to duplicate my emergency egress time from a cockpit onto a work stand in the hangar."

Vought initially installed its own ejection seat but changed to a Martin-Baker seat which had earned a good reputation in England. The Mk F5 did not have a zero-zero capability (zero airspeed, zero altitude), however, and eventually the Mk F7 zero-zero seat was installed in late-model Crusaders.

During a cross-country flight on 14 July 1973, Reserve Lieutenant Commander Robert G. Hoch of VFP-306 experienced a flame-out. After several attempts to relight the engine of his RF-8G, BuNo. 145615, Hoch ejected at 10,000 ft (3048 m) above the Arizona desert floor. He floated down, circled all the way by his wingman and friend Lieutenant Commander Robert Norrell. (Both men would eventually command the squadron, Hoch in 1975 and Norrell in 1980.)

Above: During the work-up period for a Vietnam cruise in* Ticonderoga, *a VFP-63 pilot put this RF-8G down for a successful wheels-up landing, with apparently little damage to the aircraft. The canopy was blown to facilitate a rapid egress from the aircraft.

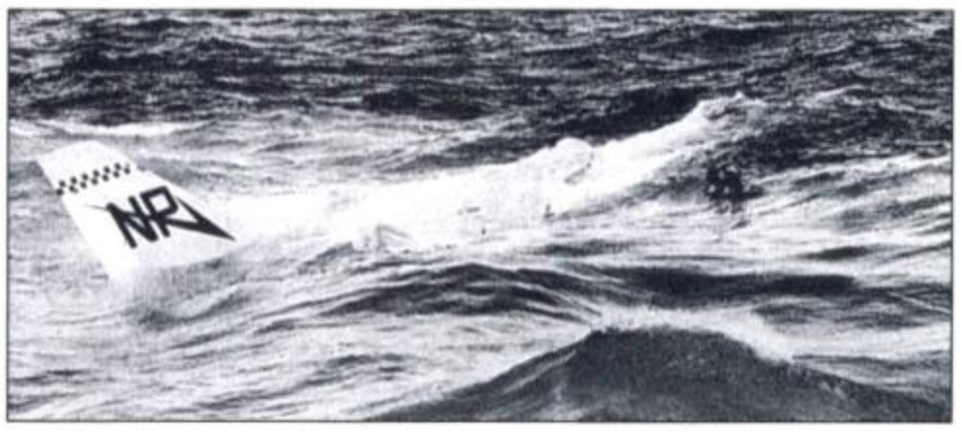
Left: The Crusader suffered its fair share of undercarriage collapses, although the short length of the gear meant that most were survivable. Here the victim is a VF-142 F8U-1.

Hoch touched down safely and, after taking off his chute and flight gear, waved at Norrell who eventually had to leave his friend because his fuel was low. At something of a loss as to what to do next, Hoch was taking stock of his situation when he heard the rumble of motorcycles in the distance.

The noise finally grew nearer and evolved into a father and son out for a day's dirt biking. They rode up to the downed pilot as a Reserve C-130 flew over, the crew kicking out a cold six-pack of beer. Things were looking up as Hoch climbed aboard one of the bikes, holding onto a can of beer with one hand and the driver with the other. The bikers took him to a military hospital where Hoch knew he would have trouble explaining the alcohol in his bloodstream. Drinking and flying are frowned on, always have been. Somehow, he got through the doctor's exam.

Short-wing flights

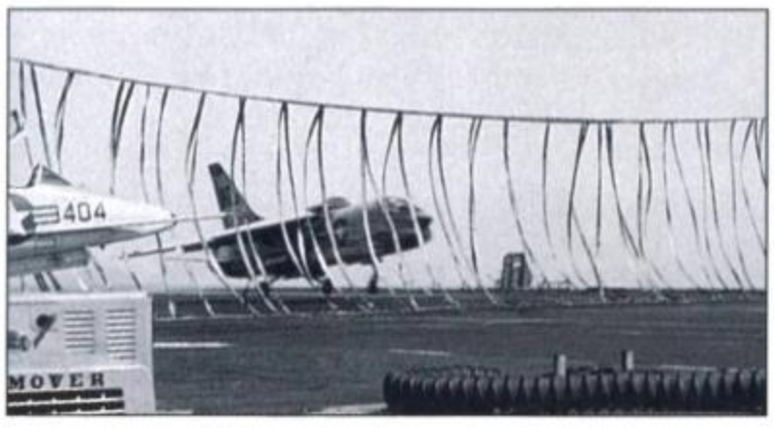
And then there are the pilots who insist on discovering new ways to fly, new aircraft configurations, or just enjoy tempting fate. One characteristic of many naval aircraft is their folding wings, which facilitate storage below decks. A few enterprising aviators have occasionally tried to take off

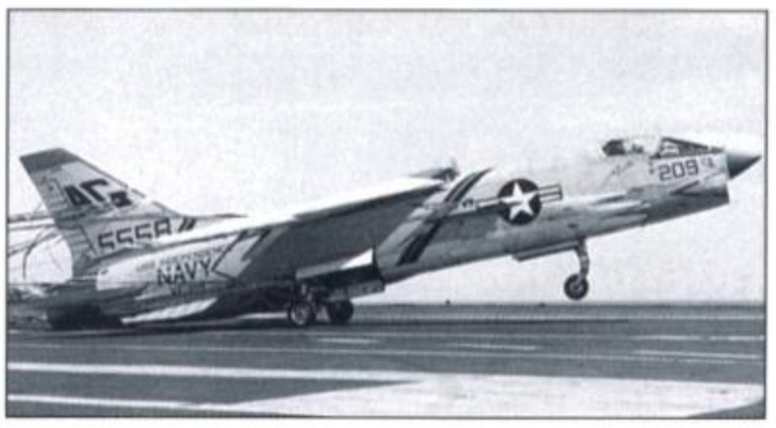


After the tailhook of his F-8C failed, Lt(jg) Tom Irwin, later a rear admiral, took a ride over the side in his VF-24 F-8C. The Crusader stayed afloat long enough for him to scramble out, and he can be seen waving for the plane-guard helicopter.

Successful barrier engagement

This sequence shows a textbook barrier engagement as a VF-84 F8U-2 lands back aboard* Independence *in 1962. Note how the aircraft is thrown back into the air by the effect of the barrier.

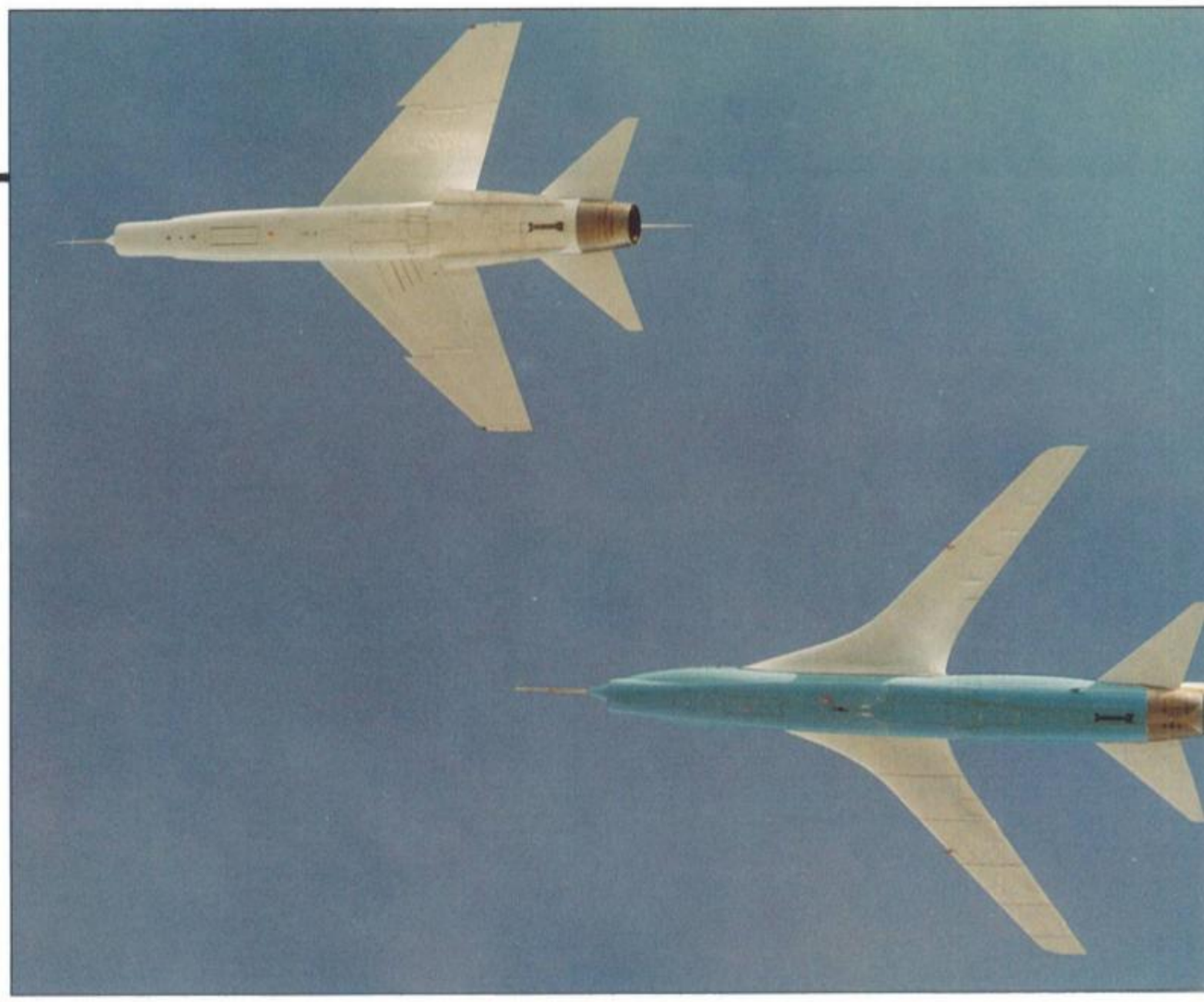




Supercritical wing

In June 1971 NASA flew a highly modified Crusader fitted with a supercritical wing of completely new design. The aircraft operated with the wing until a more refined supercritical wing was fitted to an F-111. The Crusader is now on display outside NASA's Dryden facility at Edwards AFB.

Above: The supercritical wing section had an almost flat top and curved underside with a reflexed trailing edge.



Above: In addition to the new wing, the Supercritical Wing Crusader had cheek bulges added for area-ruling. Other bulges were added to the rear fuselage.

Top right: Seen in flight with a standard F-8C, the Supercritical Wing aircraft displays its unique planform.

Right: The XF8U-3 was the prototype for a follow-on fighter to the F-8, known as the Crusader III. It shared some features with the original, but was otherwise a completely different aircraft.

Below right: Following initial flight trials between 1979 and 1982 using the purpose-built NASA/Ames AD-1, it was proposed to fly the slew-wing concept on F-8C NASA 802, but the project was shelved.

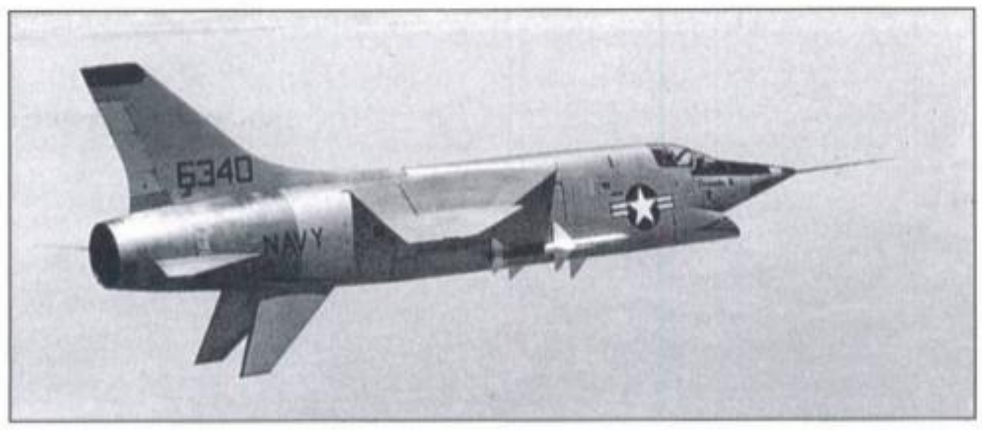
Below: NASA 802 became the vehicle for a digital fly-by-wire system. The aircraft could have its flight control software reprogrammed to mimic the handling of other aircraft. It was used, among other duties, to test certain aspects of the Space Shuttle's handling.

with their wings folded – and succeeded. The F-8 has had more than its share of such incidents; seven to be exact.

The first incident occurred on 2 August 1960, when a VF-11 F8U-1 pilot took off from Naples, Italy and flew for 24 minutes before landing safely, his wings still folded. Five F-8Es did the wings-folded trick, one in 1964, one in 1966, two in 1967 and one in 1968. Lieutenant Commander Tom Hudner took off at night in an F-8E. Hudner, who had won the Medal of Honor in Korea trying to rescue a squadron mate who had been shot down, climbed to 10,000 ft (3048 m) and rocked his aircraft from side to side in a successful effort to force the wingtips down.

Two Marine pilots of VMF(AW)-235 at Da Nang made wings-folded take-offs in 1966 and 1967. In the latter, the Crusader was fully loaded with two 2,000-lb bombs, six Zunis and a full bag of 20-mm ammunition; the pilot jettisoned his load and made an uneventful recovery. The pilot in the 1966 incident also recovered, but he forgot to lower his landing gear. It probably was not one of his better days.

The final Crusader wings-up take-off involved an F-8J on 28 January 1969, during carrier-landing practice. As the pilot reached rotation speed, the LSO called to tell him his wings were still folded. He quickly came out of 'burner, lowered his hook and engaged the arresting gear.



The last ejection

During Vietnam, the Crusader saw widespread use in the Reserves, and that service contributed to the ejection rate on many occasions. The first ejection from a Reserve Crusader occurred on 9 January 1965, when the pilot of a Dallas F-8A punched out. A Washington Reservist left his VF-661 F-8B the following month. Although the Reserves enjoyed a fairly good reputation and a commensurate loss rate, it fell to a Reservist to make the last ejection from a US Crusader.

Commander David Strong, executive officer of VFP-206, was number two in a two-aircraft flight from NAS Miramar on 11 March 1985. After pre-flighting his RF-8G, BuNo. 146855, AF 606, Strong climbed in and he and his lead taxied to Runway 24-Left. Immediately after take-off, both pilots came out of afterburner, but Strong felt and heard an explosion and his power began to quickly decay. Failing to relight his engine, he turned his attention to steering his aircraft away from an office park near the runway and instead toward the ocean. He could not make it and ejected at 170 kt (313 km/h) and 250 ft (76 m) above the ground, with his aircraft in a right roll, outside the envelope of the seat.

The ejection went well, however, and deposited Strong in a street 200 ft (61 m) from the crash site. Divesting himself of his parachute and flight gear, Commander Strong began helping fire crews to fight the fire ignited by the crash. Secretary of the Navy John Lehman awarded Commander Strong a rare peacetime Distinguished Flying Cross for his courage in staying with his aircraft beyond the limits required in order to keep away from a populated area.

Between 4 May 1956 and 11 March 1985 the US Navy and Marine Corps counted no less than 493 F-8 ejections. Of the 1,261 Crusaders built for the US forces, 517 were lost in operations, around 41 per cent of the original complement.

Besides the six basic models of the F-8 (A through E, and RF-8A), the four remanufactured fighters (H, J, K, L) and RF-8G, the French E(FN), and the one-off TF-8A 'Two-sader', a few additional variations were built. The

XF8U-3 Crusader III was a completely different aircraft, which incorporated a lot of Crusader experience but is outside the scope of this article.

The Supercritical Wing Crusader

Aerodynamic research was an area in which the F-8 was involved. In 1969 NASA issued a requirement for design and construction of a new wing. Called the supercritical wing, the new airfoil reversed the shape of a conventional wing by having the top surface flat and the bottom surface curved. During wind tunnel tests, it was found that the new wing allowed aircraft to cruise at speeds closer to Mach 1 without the disconcerting and troublesome buffeting that accompanied sustained flight at that high speed. It was also hoped that the supercritical wing would reduce take-off and landing distances as well as contribute to low-speed handling characteristics.

Initial tests were conducted with a T-2 trainer, but by June 1971 an F-8A had been fitted with the new wing. Compared with the normal F-8 wingspan of over 35 ft (10 m), the Supercritical Wing F-8 had a span of 43 ft (13 m). The F-8 was painted with a cerulean blue fuselage, and white wings and horizontal tail surfaces. The slender, long-span wings imparted a birdlike quality to the aircraft's appearance. This Crusader completed its part in the test programme, and the General Dynamics F-111 was the next aircraft to pick up the Supercritical Wing programme in 1973.

A civilian Crusader

Perhaps a fitting note on which to end this narrative of the career of the F-8 series is to tell of one Crusader which still flies, albeit with civilian registration numbers. While other retired military aircraft can be found still serving in various capacities, or thrilling weekend air show crowds, the F-8 is a rare bird in the common man's world. Expense, the scarcity of flyable examples and the Crusader's demanding attributes are all probable reasons for the lack of a privately owned F-8.

But, on 12 March 1987, F-8 N19TB made its first flight, with F-8 veteran Dudley Moore proudly at the controls. Owned and operated by Thunderbird Aviation of Phoenix, Arizona, the Crusader was a hybrid, with the fuselage and tail of and F-8K and the wing of and F-8L. Parts were obtained from LTV Products Group and salvage yards. The engine is a Pratt & Whitney J57-P-55. The modifications number in the hundreds as the aircraft has been

modernised. Non-essential military equipment was stripped, including armour, radar, gunsight and gun chutes. The basic weight is 19,500 lb (8845 kg).

The F-8 contains state-of-the-art UHF/VHF radios, NAVSTAR Loran C, and VOR/DME (Switched). Navigational information is fed into a modern horizontal situation indicator (HSI). Everything, including the APC, works like the original. The ejection seat is vintage Martin-Baker, modified with a custom 28-ft (8.5-m) chute. The face curtain and canopy interrupter are gone. Ejection is through the canopy, and the seat pack contains only the emergency oxygen bottle. A custom video pod facing aft plus a custom high-speed camera installation in the gun compartments are used for flight test procedures. The completion of the F-8 rebuild took 2½ years and 19,000 man-hours, and $2,000,000, which is about the original cost in 1960 dollars.

Moore did all the flight test and development work, involving 20 flights. The one-of-a-kind Crusader participated in supersonic flight-test work at White Sands Missile Range. Moore, an airline pilot and retired Naval Air Reserve captain, has flown it to Mach 1.5 (1,000 mph; 1610 km/h) and reports that it performs beautifully. Fittingly, Moore received an FAA licence to fly the F-8 on 25 March 1987, the 32nd anniversary of the Crusader's first flight in 1955. A second Crusader, an F-8K, also joined Thunderbird in 1989 and occasionally visits air shows.

The Crusader series was probably built in insufficient numbers to expect the aircraft to find its way into many museums or private air forces, even though Vought's last production fighter was one of the most important naval aircraft of the post-Korea period. But, from 1956 to 1973, for many naval aviators, there was really only one choice.

Peter B. Mersky

Above: Thunderbird Aviation maintains this flying example of the Crusader, a hybrid of F-8K fuselage and F-8L wings. It has many non-standard features, including modern radios, rear-facing video pod and forward-facing cameras.

Above left: Very few Crusaders have been preserved, this F-8A being on the gate at NAS Oceana (in totally spurious squadron markings and BuNo.). The XF8U-1 is in the Museum of Flight in Seattle, while the Naval Aviation Museum has five, four of which are on loan: RF-8G on the USS Alabama, F-8A at Cecil Field, F-8A in Delaware, F-8J in Atlanta and one F-8A in the main museum at Pensacola.

Below left: Several Crusader airframes ended their days ignominiously as targets on ranges. This gaudily camouflaged RF-8G resided on San Clemente Island off the Californian coast until expended in this attack on 3 November 1987. The attacking weapon was a submarine-launched Tomahawk cruise missile releasing combined effects muntions.

Below: This ex-VFP-306 RF-8 was operated by Rockwell International on chase duties. In the 1990s it was used to follow the Rockwell/MBB X-31 supermanoeuvrability research aircraft.

F-8 Operators

Production of the Crusader amounted to 1,261 airframes, comprising the following – XF8U-1: 2, F8U-1 (F-8A): 318, F8U-1E (F-8B: 130, F8U-1P (RF-8A): 144, F8U-2 (F-8C): 187, F8U-2N (F-8D): 152, F8U-2NE (F-8E): 286 and F-8E(FN): 42. Conversions accounted for 73 RF-8Gs (from RF-8A), 89 F-8Hs (from F-8D), 136 F-8Js (from F-8E), 87 F-8Ks (from F-8C) and 61 F-8Ls (from F-8B). Small numbers were produced by conversion to serve as pre-production aircraft for new variants, one of which (XF8U-2NE) was further converted to two-seat XF8U-1T status. Several F8U-1Ds (DF-8s) were modified for drone direction and there were a few F8U-1KD (QF-8A) drones.

F-8 squadrons were noted for their colourful markings. This is VF-194's CAG-bird F-8E: the tail wears the colours of the squadrons in the air wing.

US Navy

Fleet Utility/Composite Squadron One (VU-1/VC-1)

'Unique Antiquers'/'Blue Aliis'
VU-1 flew five F-8As and three DF-8As in the 1960s from NAS Barbers Point, Hawaii. Changing to VC-1 in 1965, it also included five F-8Cs. Relinquishing its Crusaders in 1969, it flew TA-4Js. Decommissioned in 1992.

DF-8F drone director of VC-1

Fleet Utility/Composite Squadron Two (VU-2/VC-2)

'Blue Tails'
Serving from NAS Oceana in Virginia's Tidewater from 1960, VU-2 flew F-8As. Squadron redesignated VC-2 in 1965, and transitioned from Crusaders to A-4s in 1971. Decommissioned in 1980.

F-8Cs of VU-2

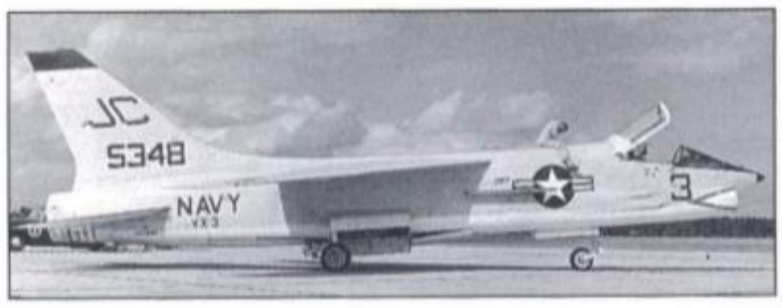
All-Weather Fighter Squadron Three (VF[AW]-3)

'Blue Nemesis'
VC-3 provided night-fighter and -attack dets to the Pacific Fleet. With the arrival of F4D Skyrays, the squadron was redesignated VF(AW)-3 in 1956. Crusader joined squadron in 1958. Decommissioned in 1963.

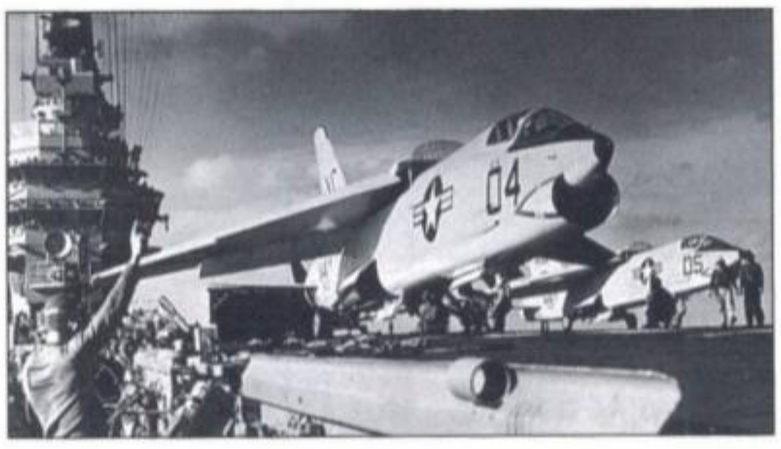
F8U-1 of VF(AW)-3 seen at NAS Moffett Field

Air Development Squadron Three (VX-3)

VX-3 received its first F-8A in late 1956 and proceeded to work the new fighter through various initial operations, including carrier qualifications and the use of the new mirror-landing system.



F8U-1s of VX-3, aircraft below on USS **Forrestal**



Air Development Squadron Four (VX-4)

'The Evaluators'
Used all models of the Crusader for weapons development, particularly the Sidewinder and Zuni. Flew the Crusader through the 1970s. Decommissioned in 1994.

F-8D of VX-4 over NAS Point Mugu

Fleet Utility/Composite Squadron Four (VU-4/VC-4)

'Dragon Flyers'
VU-4 was redesignated VC-4 in 1965, having flown F-8Cs from 1961. Squadron flew F-8Bs and F-8Ks until being disestablished in 1971.

F-8Cs from VU-4

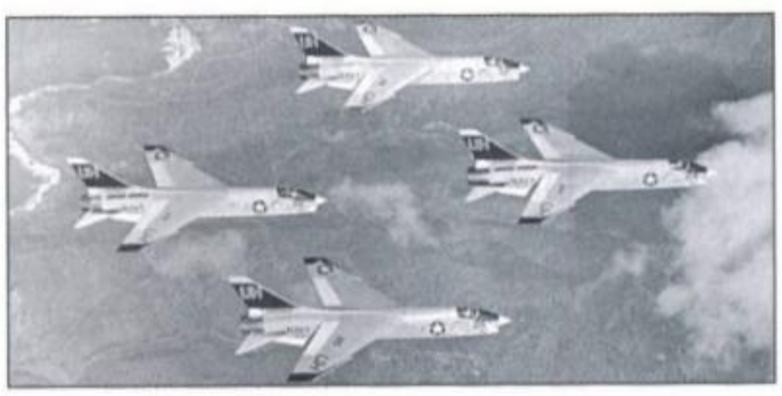
Fleet Utility/Composite Squadron Five (VU-5/VC-5)

'Workhorse of the Fleet'
VU-5 received its first F-8As in 1962, replacing them with F-8Ds when it was redesignated VC-5 in 1965. Squadron flew F-8A, B, C, D, K, and DF-8Fs. VC-5 towed targets for Pacific Fleet squadrons, and provided adversary services with A-4s until being disestablished in 1992.

DF-8F (above) and F-8K (below) of VC-5

Fleet Utility/Composite Squadron Seven (VU-7/VC-7)

'Tallyhoers'
Squadron flew F-8As from NAS Miramar in 1964. Also flew F-8C, F-8K and DF-8F before decommissioning in 1970. Squadron also flew four RF-8As beginning in 1967. Decommissioned in 1980.



F-8Cs of VC-7

Fleet Utility/Composite Squadron Eight (VU-8/VC-8)

'Red Tails'
Based at Roosevelt Roads, Puerto Rico, squadron took first Crusaders in 1963, flying DF-8Fs. Designated VC-8 in 1965, flew Crusaders until 1973.

DF-8F of VC-8

Fleet Utility/Composite Squadron Ten (VU-10/VC-10)

'Proud Pelicans'/'Challengers'
Flew Crusaders from 1962, and redesignated VC-10 in 1965. Operated F-8A, B, D, and K until 1974. Based at Guantanamo Bay, Cuba.

F-8A of VU-10

F-8K of VC-10 after mishap at Guantanamo Bay

Fighter Squadron Eleven (VF-11)

'The Red Rippers'
Operated Crusaders from 1959 to 1966, flying F-8A, D and E. Transitioned to F-4B in 1966. Currently flying the F-14D.

F-8Es of VF-11 'Red Rippers'

Composite Squadron Thirteen (VC-13)

'Fightin' Saints'
One of two Naval Air Reserve adversary squadrons, VC-13 was commissioned in 1973; squadron took F-8Hs from earlier VCF-76 and VCF-86. Relinquished Crusaders for A-4Ls in 1974. Flew A-4F and TA-4J until 1994 when it transitioned to the F/A-18A, only to move from NAS Miramar to NAS Fallon in 1996 and take VFA-127's F-5s.

F-8Hs of VC-13 'Fightin' Saints'

Fighter Squadron Thirteen (VF-13)

'Night Cappers'
Based at NAS Cecil Field, VF-13 traded its F3Hs for F-8Es in 1964. Transitioned to F-8D in 1966, then to the F-8C, and finally the F-8H. Squadron disestablished in 1969.

F-8E of VF-13, seen at NAS Miramar in 1966

Fighter Squadron Twenty-Four (VF-24)

'Checkertails'
First F-8As arrived in 1957. VF-24 flew F-8Cs in several carriers during Vietnam, claiming four MiGs. Flew F-8H and J through 1975 when squadron transitioned to the F-14A.

F-8J of VF-24 in late-period markings

F-8H of VF-24, note squadron MiG kills

Fighter Squadron Twenty-Six (VF-26)

'Sundowners'
Derived from VF-111 in 1964 but only existed for two and one-half weeks. Equipped with F-8Ds.

Fighter Squadron Thirty-Two (VF-32)

'Swordsmen'
First fleet Crusader squadron, taking first F-8As in 1957. Flew F-8B and D. Transitioned to the F-4B in 1965, then to the F-14A in 1974.

F8U-1s (above) and F-8D (below) of VF-32

Fighter Squadron Thirty-Three (VF-33)

'Tarsiers'
Squadron acquired F8U-1Es (F-8Bs) in 1961, switching to F-8Es in 1962. Transitioned to F-4s in 1964, and F-14s in 1981. Decommissioned in 1995.

F-8E of VF-33 'Tarsiers'

Fighter Squadron Fifty-One (VF-51)

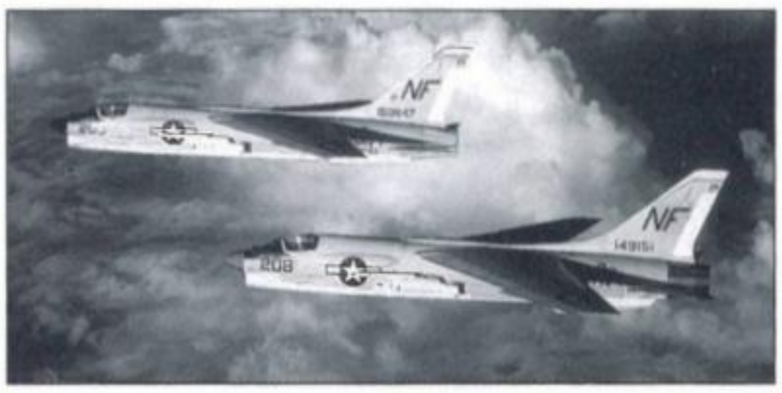
'Screaming Eagles'
Transitioned from F4D to F-8 in 1961. Flew F-8E and F-8H during several Vietnam cruises, including the initial Gulf of Tonkin Incident, claiming two MiGs with F-8Hs. Squadron also claimed four MiGs with F-4B. Moved to F-14A in 1977. Decommissioned in 1995.

F-8E from VF-51

F-8Es from VF-51 (foreground) and VF-53

Fighter Squadron Fifty-Three (VF-53)

'Iron Angels'
Flew Crusader beginning in 1963, and participated in Gulf of Tonkin Incident of August 1964, flying F-8Es. Squadron claimed two MiGs, flying F-8Es, later transitioned to the F-8J in 1968. Squadron disestablished in 1971.



F-8Es of VF-53, USS **Ticonderoga**

Composite Photographic Squadron Sixty-One (VCP-61)

F8U-1Ps joined VAP-61 in 1959. Squadron was redesignated VCP-61. It reverted to VAP-61 designation in 1961, relinquishing its photo-Crusaders. Squadron decommissioned in 1971.

RF-8A of VCP-61 on USS **Midway**

Light Photographic Squadron Sixty-One (VFP-61)

VFP-61 received F8U-1Ps in 1957. Later redesignated VCP-63.

F8U-1P of VFP-61 takes the barrier in January 1959

F-8 Operators

Fighter Squadron Sixty-Two (VF-62)

'Boomerangs'
One of the primary Atlantic Fleet Crusader squadrons until its disestablishment in 1969, VF-62 received its first F-8As in 1960. Later flew F-8Bs and Es. Decommissioned in 1969.

***F8U-1s of VF-62 on board USS* Enterprise**

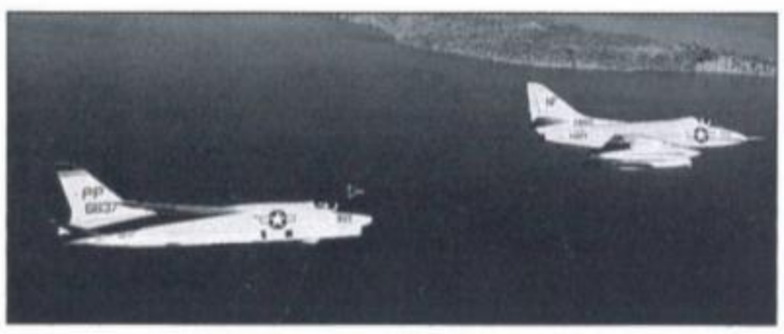
Light Photographic Squadron Sixty-Two (VFP-62)

'Fightin' Photo'
Received first F8U-1Ps in 1958, and served as the main naval reconnaissance squadron during 1962 Cuban Missile Crisis. RF-8As gave way to RF-8Gs in 1965. Squadron decommissioned in 1968.

F8U-1P of VFP-62

Composite Photographic Squadron Sixty-Three (VCP-63)

'Cameras Unlimited'
VFP-61 redesignated VCP-63 in 1959. Flew F8U-1Ps.



F8U-1P of VCP-63 refuels from a Douglas A4D

Light Photographic Squadron Sixty-Three (VFP-63)

'Eyes of the Fleet'
One of the most important Navy Crusader squadrons, and ultimately the last fleet F-8 squadron, VFP-63 was established in 1961 from VCP-63. Squadron flew Crusaders for 21 years until disestablishing in 1982. Squadron flew RF-8A and G, as well as the F-8H and J. Assumed Crusader training duties in 1975, mainly involving training transitioning photo-reconnaissance pilots from earlier F-8 fighter units, as well as for newly established reserve units.

RF-8G (above) and F-8J (below) of VFP-63

RF-8G of VFP-63 in final scheme, 1981

Anti-Submarine Fighter Squadron Seventy-Six (VSF-76)

'Fighting Saints'
Based at NAS New Orleans, squadron flew F-8Hs from 1971 until 1973, when it was combined with VSF-86 into VC-13, which took the H models for a short time.

F-8H of VSF-76 at NAS Cecil Field

Fighter Squadron Eighty-Four (VF-84)

'Vagabonds'/'Jolly Rogers'
Squadron received F8U-2s (F-8Cs) in 1961. Transitioned to F-4Bs in 1964, then to F-14As in 1976. Decommissioned in 1995.

F-8Cs of VF-84 show variations on flaming mouth intake markings

Anti-Submarine Fighter Squadron Eighty-Six (VSF-86)

'Gators'
Based at NAS New Orleans alongside VSF-76, squadron also flew F-8Hs from 1971 until 1973, when it was combined with VSF-76 into VC-13, which took the H models for a short time.

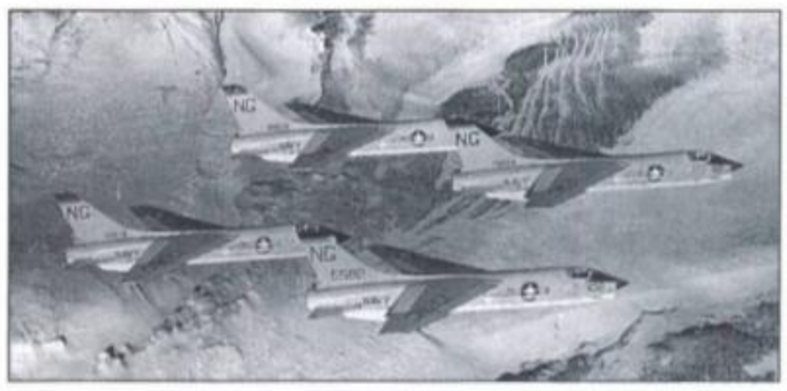
F-8H of VSF-86

Training Squadron Eighty-Six (VT-86)

'Sabre Hawks'
An odd equipping for a training squadron, but VT-86 at NAS Glynco, south of Savannah, Georgia, operated F-8As to train pilots in using the AN/APQ-94 fire-control radar in the Crusader's nose. Later, radar was installed in the T-39Ds now flown by the Naval Air Technical Training Command (NATTC) to train F-4 radar intercept officers (RIOs).

Fighter Squadron Ninety-One (VF-91)

'Red Lightnings'
VF-91 received its Crusaders in 1958, moving to F8U-2s in 1959. Squadron redesignated VF-194 (which see) in 1963.



F8U-2s of VF-91

Fighter Squadron One Hundred and Three (VF-103)

'Sluggers'
Squadron transitioned to F8U-1 in 1957. Moved to F8U-2s in 1959, then to Es in 1963. VF-103 transitioned to F-4Bs in 1965, then to the F-14A in 1981. In an odd sequence of events, when VF-84 decommissioned in 1995, VF-103 took the 'Jolly Rogers' nickname and skull-and-crossbones logo.

F-8Cs of VF-103 'Sluggers'

Fighter Squadron One Hundred and Eleven (VF-111)

'Sundowners'
Received F8U-2Ns (F-8Ds) in 1961, and was one of only two squadrons to fly the D in combat. Moved to F-8C then F-8E in 1966. In 1968, a detachment in USS *Intrepid* (CVS-11) gained the last confirmed F-8 MiG kill in Vietnam. Squadron flew F-8Hs in 1969, then transitioned to the F-4B in 1971. VF-111 claimed another MiG in Phantoms in 1972. Squadron moved to the F-14A in 1977. Decommissioned in 1995.

F-8H of VF-111 'Sundowners'

F-8D of VF-111 fires Zuni rockets on 1965 mission

Fighter Squadron One Hundred and Twenty-Four (VF-124)

'Crusader College'
Originally based at NAS Moffett Field, VF-124 moved to NAS Miramar in 1961 to assume the duties of training F-8 pilots for the Pacific Fleet. With the appearance of the F-14 in the early 1970s, VF-124 turned over its Crusader responsibilities to VFP-63 and began training Tomcat crews. Decommissioned in 1994.

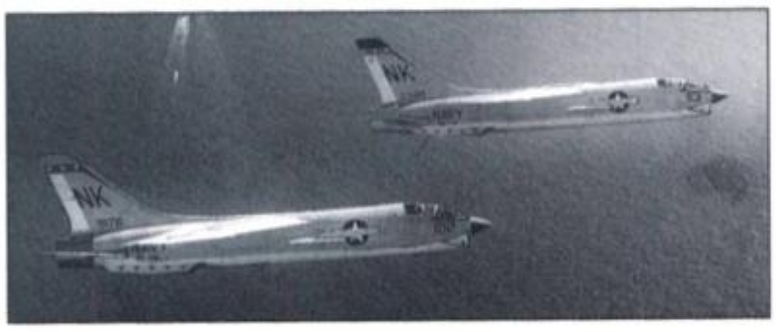
F-8D/E (above) and F-8J (below) of VF-124

Fighter Squadron One Hundred and Thirty-Two (VF-132)

'Pegleg Petes'
Squadron acquired F8U-2Ns (F-8Ds) in 1961, but was decommissioned only a year later.

Fighter Squadron One Hundred and Forty-One (VF-141)

'Iron Angels'
Trading its Demons for F-8Es in 1962, VF-141 was redesignated VF-53 (which see) in 1963.



F-8Es of VF-141 'Iron Angels'

Fighter Squadron One Hundred and Forty-Two (VF-142)

'Fighting Falcons'
Squadron received its first F-8As in 1957, moved to F8U-2s (F-8Cs) in 1959, then back to F-8As in 1961. Transitioned to F-4s in 1962. Redesignated VF-96, eventually becoming the highest-scoring Navy squadron in Vietnam, claiming 10 MiGs. Disestablished in 1975.

F8U-1 of VF-142

Fighter Squadron One Hundred and Fifty-Four (VF-154)

'Grand Slammers'/'Black Knights'
Squadron acquired its first F-8As in 1957 as the first Pacific Fleet Crusader squadron. Changed name to 'Black Knights' in 1963. Received F-8Bs in 1960, and F8U-2Ns (F-8Ds) in 1962. VF-154 flew Ds from USS *Midway* (CVA-41) in Southeast Asia, losing several aircraft in combat and operational mishaps. Squadron changed to Phantoms in 1965, then to the F-14A in 1983. It is currently flying Tomcats forward deployed in Japan.

F8U-2N s of VF-154 'Grand Slammers'

Fighter Squadron One Hundred and Sixty-Two (VF-162)

'Hunters'
VF-162 gave up its F-4Ds for F-8As in 1962, changing to F-8Es in 1964. The 'Hunters' flew through several early combat cruises in Vietnam, claiming two MiGs. They flew H and J models later in the war. Squadron was decommissioned in 1970.

F-8E of VF-162

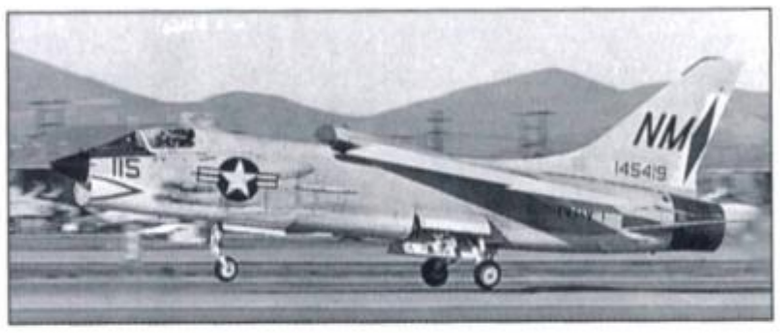
Fighter Squadron One Hundred and Seventy-Four (VF-174)

'Hellrazors'
As the East Coast Crusader training squadron, VF-174 provided F-8 pilots for the Atlantic Fleet. It also trained French pilots. Eventually, it acquired on the A-7 Corsair II, and was redesignated VA-174. Squadron was decommissioned in 1988.

F-8C (background) and F-8D of VF-174

Fighter Squadron One Hundred and Ninety-One (VF-191)

'Satan's Kittens'
VF-191 received its F-8As in 1960, changing to F-8Es in 1963. Squadron flew some of the earliest combat missions in Vietnam and claimed one MiG kill. It switched to F-8Js in 1968, and eventually made the last Crusader deployment in 1975. VF-191 transitioned to F-4s in 1976, but was soon decommissioned in 1978. Squadron was recommissioned for a short time on F-14As, but was finally disestablished in 1988 because of budget cuts.



F-8B (above) and F-8J (below) of VF-191

Fighter Squadron One Hundred and Ninety-Four (VF-194)

'Red Lightnings'
Derived from VF-91 (which see), VF-194 flew F-8Cs from 1963, also participating in early combat action in Vietnam. Re-equipped with F-8Es in 1964, flying several combat tours, before changing to F-8Js in 1968. Squadron made the last deployment with F-8s in 1975, then went to Phantoms in 1976, only to be decommissioned in 1978. Recommissioned on F-14s in 1986, but budget cuts forced a final decommissioning in 1988.

F-8Js of VF-194 'Red Lightnings'

Fighter Squadron Two Hundred and One (VF-201)

'Hunters'
Established under the 1970 reorganisation of the Naval Air Reserve, VF-201 originally flew F-8Ks, then F-8Hs. Transitioned to the F-4 in 1976, then to the F-14 in 1986.

F-8H of VF-201

F-8 Operators

Fighter Squadron Two Hundred and Two (VF-202)

'Superheats'
Like VF-201, the 'Superheats' – originally a nickname for VF-162 – flew F-8Hs, Phantoms and F-14As. Decommissioned in 1994.

F-8H of VF-202 'Superheats'

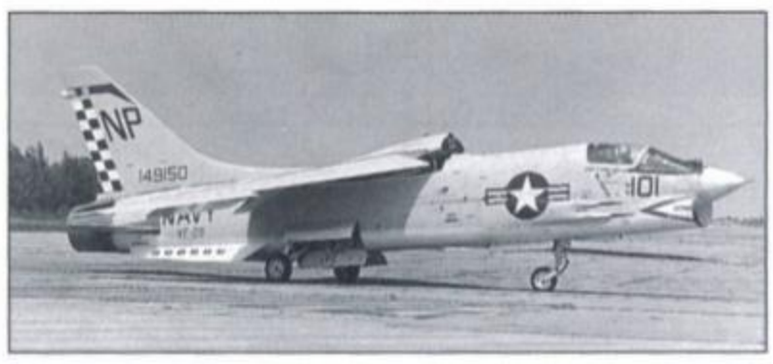
Light Photographic Squadron Two Hundred and Six (VFP-206)

'Hawkeyes'
Reserve unit established in 1970 with RF-8Gs. Squadron ultimately served as the last US Navy Crusader squadron, decommissioning in 1987.

RF-8Gs of VFP-206

Fighter Squadron Two Hundred and Eleven (VF-211)

'Checkertails'
One of the most successful Crusader squadrons in Vietnam, VF-211 was redesignated VF-24 and VF-24 redesignated VF-211 in 1959. The second VF-211 flew F-8As, then F-8Es, beginning in 1964. The squadron served in several carriers, mainly USS *Hancock* (CVA-19) and USS *Bon Homme Richard* (CVA-31). The 'Checkertails' eventually claimed seven MiGs, including the first three Crusader kills in 1966. VF-211 changed to F-8Js in time for the 1972 combat cruise, flying the J model until 1975, when it transitioned to the F-14.



F-8E (above, with MiG kills) and F-8J of VF-211

Fighter Squadron Three Hundred and One (VF-301)

'Devil's Disciples'
Established with the reorganisation of the Naval Air Reserve in 1970, VF-301 flew F-8Js before moving to F-4s in 1974. Squadron transitioned to F-14 in 1984. Decommissioned in 1994.

F-8J of VF-301 'Devil's Disciples'

Fighter Squadron Three Hundred and Two (VF-302)

'Stallions'
Established in 1971 with F-8Ks, then F-8Js, VF-302 later went to F-4s in 1973, then F-14s in 1985. Decommissioned in 1994.

F-8J of VF-302

Light Photographic Squadron Three Hundred and Six (VFP-306)

'Peeping Toms'/'Photomasters'
Reserve unit, established in 1970 with RF-8Gs. Squadron changed its nickname late in its career, around 1981. Decommissioned in 1984.

RF-8G of VFP-306

Fighter Squadron Six Hundred and Sixty-One (VF-661)

'Firefighters'
One of three pre-1970 Reserve squadrons flying Crusaders, VF-661 shared F-8As, then Bs, with Marine Reserve Squadron 321 (which see). Recalled during the 1968 *Pueblo* Crisis, VF-661 deployed to Cecil Field to transition to the F-8H. Overall poor showing by Reserves resulted in release from active duty and decommissioning in 1968.

F-8Hs of VF-661

Fighter Squadron Six Hundred and Sixty-Two (VF-662)

When VF-661 was mobilised in 1968, VF-662 acquired its F-8Bs and operated them until 1970 reorganisation resulted in VFP-206 and VFP-306 commissioning.

Fighter Squadrons Six Hundred and Seventy-Two (VF-672) and Six Hundred and Seventy-Three (VF-673)

Sharing F-8Cs with Marine Reserve Squadron VMF-351, these two Naval Air Reserve units then flew F-8Ls before decommissioning in 1970.

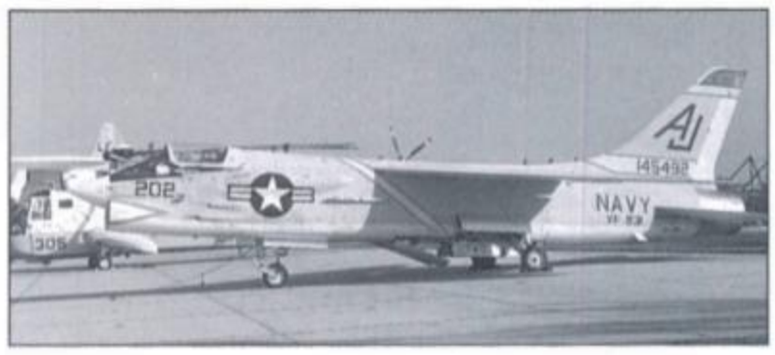
Fighter Squadron Seven Hundred and One (VF-701)

'Hunters'
Operating F-8As at NAS Dallas, then Ks, squadron was recalled in 1968 and deployed to Miramar to transition to F-8Hs. Decommissioned in 1970, 701's F-8Ks were assigned to VF-201.

F-8A of VF-701 at NAS Dallas

Fighter Squadron Nine Hundred and Thirty-One (VF-931)

Also recalled to active duty in 1968 during the *Pueblo* Crisis, VF-931 traded its F-8Bs for F-8Hs at Cecil Field. Decommissioned in 1970.



F-8A (above) and F-8B (below) of VF-931

Fighter Squadron Nine Hundred and Thirty-Two (VF-932)

Flew F-8Bs from 1964 with VF-931. Redesignated VF-33W2 in 1968, later acquiring F-8Ls before decommissioning in 1970.

Naval Air Test Center, Patuxent River (NATC)

Located at NAS Patuxent River in southern Maryland, NATC (now NAWC, AD) conducts development and suitability

trials for new Navy and Marine Corps aircraft and related systems. All models of the F-8 series flew at NATC, beginning in 1957 through the 1970s.

F-8Ds of the Naval Air Test Center

F-8H of the Naval Air Test Center

Naval Weapons Center, China Lake

Various models of the Crusader flew from NWC China Lake, including DF-8Fs.

Pacific Missile Range and Naval Missile Test Center

Based at NAS Point Mugu, the NMTC flew DF-8As, Fs and Ls as drone directors, and a few F-8Js.

DF-8A and TV-2 of Pacific Missile Range

DF-8F of the Naval Missile Center

F-8Js of NMC (above) and Pacific Missile Test Center (below)

US Marine Corps

Marine Fighter Squadron One Hundred and Eleven (VMF-111)

'Devil Dogs'
A reserve squadron based at NAS Dallas, VMF-111 acquired the F-8A in 1964, turning the aircraft over to VMF-112 in 1965 when the Marine Air Reserve was reorganised.

Marine Fighter Squadron One Hundred and Twelve (VMF-112)

'Cowboys'
Commissioned as a reserve squadron in 1965, VMF-112 flew F-8As, Ks. and Hs. Squadron transitioned to F-4s in 1976, then to F/A-18s in 1992.

F-8Hs of VMF-112 (VMF[AW]-112 below)

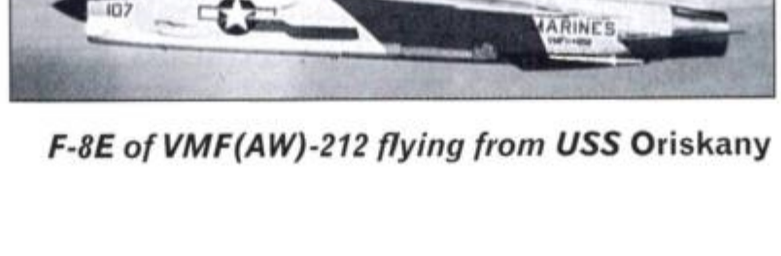
Marine Fighter Squadron One Hundred and Thirteen (VMF-113)

'Whistling Devils'
Reserve squadron at Olathe, Kansas. First F-8As arrived in April 1965 but, upon the unit's deactivation that October, aircraft moved to VMF-215.

F-8A of VMF-113 'Whistling Devils'

Marine All-Weather Fighter Squadron One Hundred and Twenty-Two (VMF[AW]-122)

'Crusaders'
The first Marine Corps squadron to carrier qualify with F-8s, VMF(AW)-122 acquired its first F-8As in 1957. Moved to F-8Es in 1962. A few F-8Bs filled in because of a shortage of Es. Squadron transitioned to F-4s in 1965, then to F/A-18s in 1986.



F-8A of VMF(AW)-122

Marine All-Weather Fighter Squadron Two Hundred and Twelve (VMF[AW]-212)

'Lancers'
Acquired F-8Bs in 1963 and redesignated an all-weather squadron, something of a misnomer due to the Crusader's relatively weak intercept radar, which was seldom used during the course of anything but a training exercise. Received F-8Ds in 1965, then Es later in the year to be equivalent to its Navy sister squadron, VF-162, on board USS *Oriskany* (CVA-34). Squadron served during the eventful 1965 combat cruise, then transitioned to F-4Bs in 1968. Changed F-4S for F/A-18A in 1988.

F-8E of VMF(AW)-212 flying from USS **Oriskany**

Marine Fighter Squadron Two Hundred and Fifteen (VMF-215)

'Fighting Corsairs'
Another reserve unit, at NAS Olathe, Kansas, VMF-215 flew F-8As and Ks beginning in 1965. Squadron deactivated in 1971.

Marine All-Weather Fighter Squadron Two Hundred and Thirty-Two (VMF[AW]-232)

'Red Devils'
One of the oldest Marine Corps aviation squadrons, the 'Red Devils' received F-8As in 1959, then F-8Bs in 1960. Changed to F-8Ds in 1965, then Es in 1966. Squadron served at Da Nang, Vietnam, for several combat tours through 1967, when it changed to F-4Js. Changed later F-4Ss for F/A-18As in 1989.

F-8A/Bs (above) and F-8E (below) of VMF(AW)-232

F-8 Operators

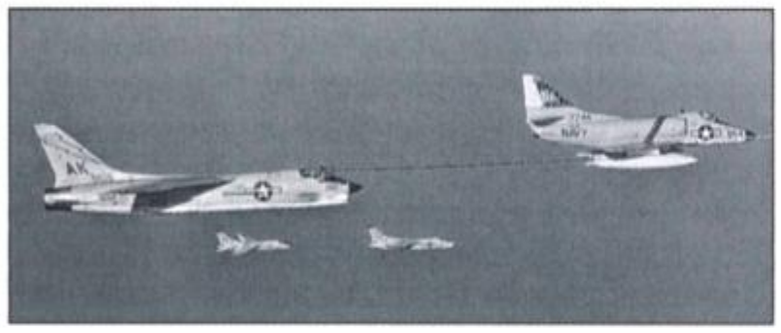
Marine All-Weather Fighter Squadron Two Hundred and Thirty-Five (VMF[AW]-235)

'Death Angels'
Received F8U-1s in 1957, then F-8Ds in 1962. Changed to F-8Es in 1964 and served several combat tours at Da Nang, Vietnam, usually exchanging aircraft with VMF(AW)-232. Transitioned to F-4s in 1968, then to F/A-18As in 1989. Decommissioned in 1996.

F-8E of VMF(AW)-235 at Da Nang

Marine Fighter Squadron Two Hundred and Fifty-One (VMF-251)

'Thunderbolts'
Acquired first F8U-1s in 1958, then F-8Bs from VMF-312. Transitioned to F-s in 1964, then to F/A-18As in 1986.



F-8B of VMF(AW)-251 refuels from an A-4

Marine All-Weather Fighter Squadron Three Hundred and Twelve (VMF[AW]-312)

'Checkerboards'
One of several combat-experienced Marine Corps squadrons, VMF-312 received F8U-1s in 1959, then F8U-1Es (F-8Bs) in 1961. Took F-8Es to Da Nang for a short combat tour in 1965. Changed to F-4s in 1966, then F/A-18s in 1988.

F8U-1E (above) and F-8E (below) of VMF(AW)-312

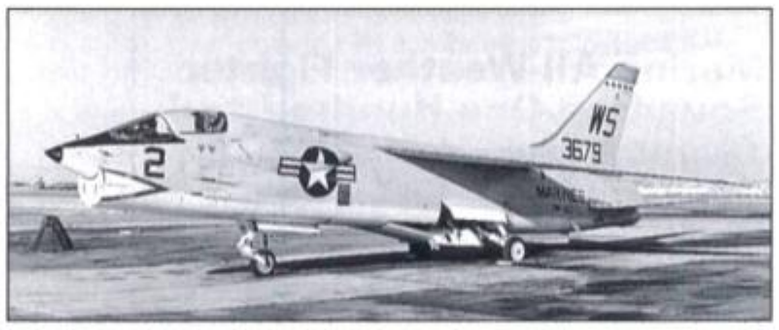
Marine Fighter Squadron Three Hundred and Twenty-One (VMF-321)

'Hells Angels'/'Black Barons'
One of the original Marine Air Reserve squadrons after World War II, VMF-321 shared F-8Bs with the Naval Air Reserve at NAF Washington, DC, beginning in 1965. With the 1971 reorganisation of the Marine Corps Reserve, VMF-321 received 19 F-8Bs. Later changing to F-8Ks, complete with a new paint scheme, squadron changed its nickname to the 'Black Barons'. Transitioned to F-4Bs in 1973, then changed its F-4Ss for F/A-18As in 1992.

F-8Ks of VMF-321

Marine All-Weather Fighter Squadron Three Hundred and Twenty-Three (VMF[AW]-323)

'Death Rattlers'
Another old squadron, the 'Death Rattlers' received F8U-1s in 1959, later changing to F-8Cs. Upgraded to F-8Es in 1962. Squadron transitioned to F-4s in 1964, and eventually to F/A-18As in 1983.



F8U-1 (above) and F-8E (below) of VMF(AW)-323

Marine All-Weather Fighter Squadron Three Hundred and Thirty-Three (VMF[AW]-333)

'Fighting Shamrocks'
Also known as 'Trip Trey', the squadron received its F8U-2 (F-8Cs) in 1959, then F-8Es in 1965. Moved to F-4s in 1968, then Hornets in 1987. Decommissioned in 1992.

F-8Cs of VMFA(AW)-333

Marine Fighter Squadron Three Hundred and Thirty-Four (VMF-334)

'Falcons'
The first West Coast Crusader squadron, VMF-334 received its F8U-1s in 1958. Squadron moved to F8U-2s in 1961. The 'Falcons' then became the first Marine F-4J squadron in 1967. After a combat tour in Vietnam, the squadron decommissioned in 1971.

F8U-1s (above) and F8U-2 (below) of VMF-334

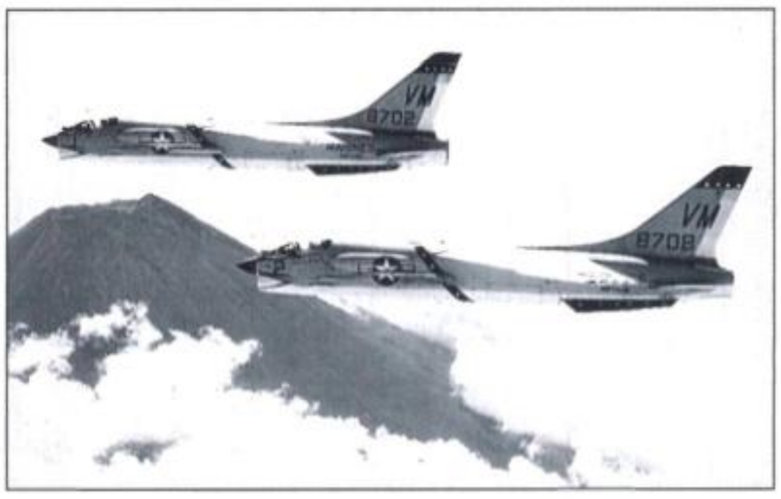
Marine Fighter Squadron Three Hundred and Fifty-One (VMF-351)

A reserve squadron at NAS Atlanta, VMF-351 received F-8As in 1965, supplemented by F-8Ls. Flying F-8Ks by 1970, squadron decommissioned in 1975.

F-8K of VMF-351

Marine All-Weather Fighter Squadron Four Hundred and Fifty-One (VMF[AW]-451)

'Warlords'
Receiving F8U-2s in 1960, squadron changed to F8U-2Ns in 1961. Changed F-8Ds for Es in 1967, then for F-4s in 1968. Transitioned to F/A-18As in 1987.



F8U-2Ns of VMF(AW)-451

Marine Fighter Squadron Five Hundred and Eleven (VMF-511)

Flew F-8Bs in 1965 at Willow Grove. Reverted to F-8As in 1968, then moved to F-8Cs in 1970 and F-8Ks in 1971. Decommissioned in 1973.

F-8K of VMF-511

Headquarters and Maintenance Squadrons (H&MS)

Known as 'Hams', these units provided technical and administrative support for marine aircraft groups (MAGs).

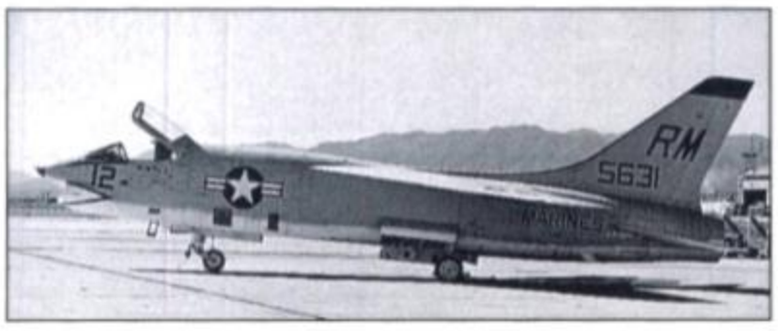
H&MS-11
Operated Crusader from 1960 to 1970.

H&MS-13 ('Outlaws')
Operated Crusader from 1960 to 1964.

H&MS-32 and H&MS-33
Both squadrons probably flew Crusaders from approximately 1959 to 1965.

Marine Composite Reconnaissance Squadron One (VMCJ-1)

'Golden Hawks'
Squadron received F8U-1Ps in 1958 and flew early photo-reconnaissance missions in Vietnam from 1964 to 1967 from shore bases and carriers.



F8U-1P of VMCJ-1 'Golden Hawks'

Marine Composite Reconnaissance Squadron Two (VMCJ-2)

'Playboys'
Sporting one of the most recognisable logos – the Playboy 'Bunny' – the squadron flew F8U-1Ps beginning in 1959. RF-4Bs replaced RF-8As by 1966.

F8U-1P of VMCJ-2 'Playboys'

Marine Composite Reconnaissance Squadron Three (VMCJ-3)

'Eyes and Ears of the Corps'
F8U-1Ps joined squadron in 1960, flying until replaced by RF-4Bs in 1966.

F8U-1P of VMCJ-3

Marine Air Reconnaissance Squadron Four (VMJ-4)

Reserve squadron at NAS Olathe, Kansas, flying RF-8As from 1961 and RF-8Gs from 1969 until 1973.

RF-8G of VMJ-4

NASA

NASA used several F-8s for airborne research programmes, such as digital-fly-by-wire (DFBW) and the supercritical wing.

'TF-8A' (above) and F-8A DFBW (below) of NASA

Civilian

Thunderbird Aviation
Phoenix, Arizona

Operates two refurbished F-8Ks for instrument work and programme development. First Crusader flew in 1987. Second aircraft joined operations in 1989.

F-8K of Thunderbird Aviation

Rockwell International
Palmdale Airport, California

Formerly North American, Rockwell obtained two RF-8Gs from VFP-306, when that reserve squadron decommissioned in 1984. Used for R&D work and later for chasing the X-31 research aircraft. The first Rockwell Crusader flew in 1987. RF-8Gs were finally grounded in 1992, with one ending up at El Toro and one at Edwards AFB.

RF-8G of Rockwell International

France

Flottille 12F
Re-established in 1964 to receive F-8E(FN)s. Embarked in carrier *Clemenceau* in May 1965. Based at Landivisiau. Received aircraft from 14F when that squadron transitioned to Super Etendards. 12F is now the sole military operator of F-8s in the world, flying the F-8P upgrade.

F-8E(FN)s of Flottille 12F

Flottille 14F

Reformed in 1965 as the second Aéronavale Crusader squadron, moving to Landivisiau. Transitioned to Super Etendards in 1979, sending its Crusaders to 12F. Unit decommissioned in 1991, but will stand up in 1998 as the first Rafale squadron.

F-8E(FN) of Flottille 14F

Philippines

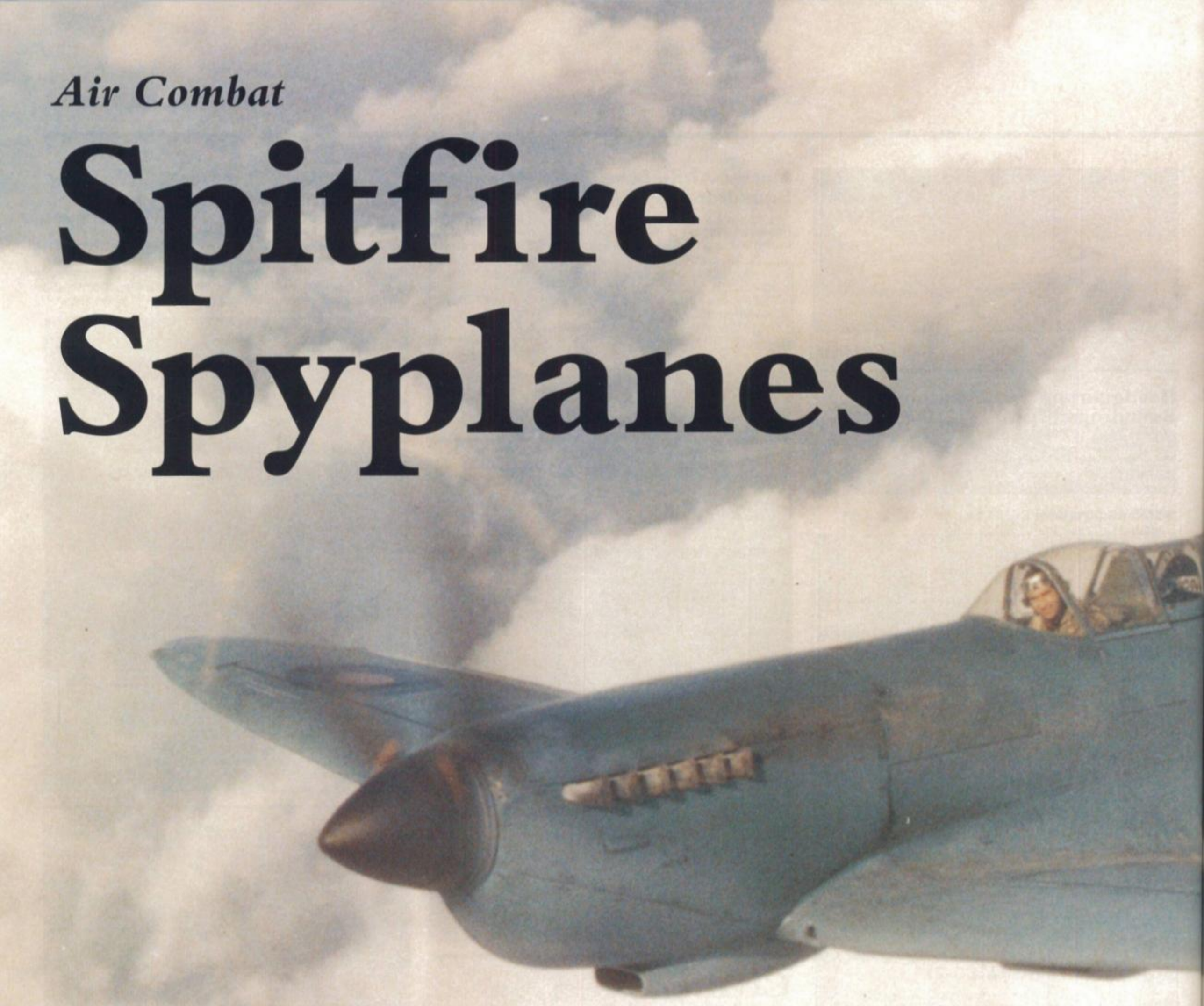
7th Tactical Fighter Squadron, 5th Fighter Wing

The Philippines acquired 35 F-8Hs in 1977. Aircraft were fairly active, but age and tropical climate, including volcanic ash from the eruption of Mt Pinatubo in 1991, took their toll. Most aircraft retired from service by 1988 to open storage by 1991.

F-8Hs of 7th TFS, 5th TFW, Philippines AF

Air Combat

Spitfire Spyplanes



The PR Specials

Today, the idea of sending a fast, high-flying unarmed reconnaissance aircraft to photograph targets, using its high performance to avoid the enemy defences, will not raise a single eyebrow. The notion is firmly accepted as a sound tactical method. In 1939, however, the conversion of a couple of Spitfire fighters to the reconnaissance role represented a radical departure from conventional military thinking. Thus modified, the aircraft quickly demonstrated their prowess in the new role. For the rest of World War II successive variants of the Spitfire ranged far and wide across enemy territory and returned with the precious photographs of their targets. Finally, almost at the end of its service career, a reconnaissance Spitfire making an inadvertent dive probably reached the greatest speed ever attained by a propeller-driven aircraft.

In August 1939, a few days before the outbreak of World War II, a junior Royal Air Force officer submitted a memorandum on the future of strategic aerial reconnaissance. In it Flying Officer Maurice 'Shorty' Longbottom stated: ". . . this type of reconnaissance must be done in such a manner as to avoid the enemy fighters and AA defences as completely as possible. The best method of doing this appears to be the use of a single small machine, relying solely on its speed, climb and ceiling to avoid detection."

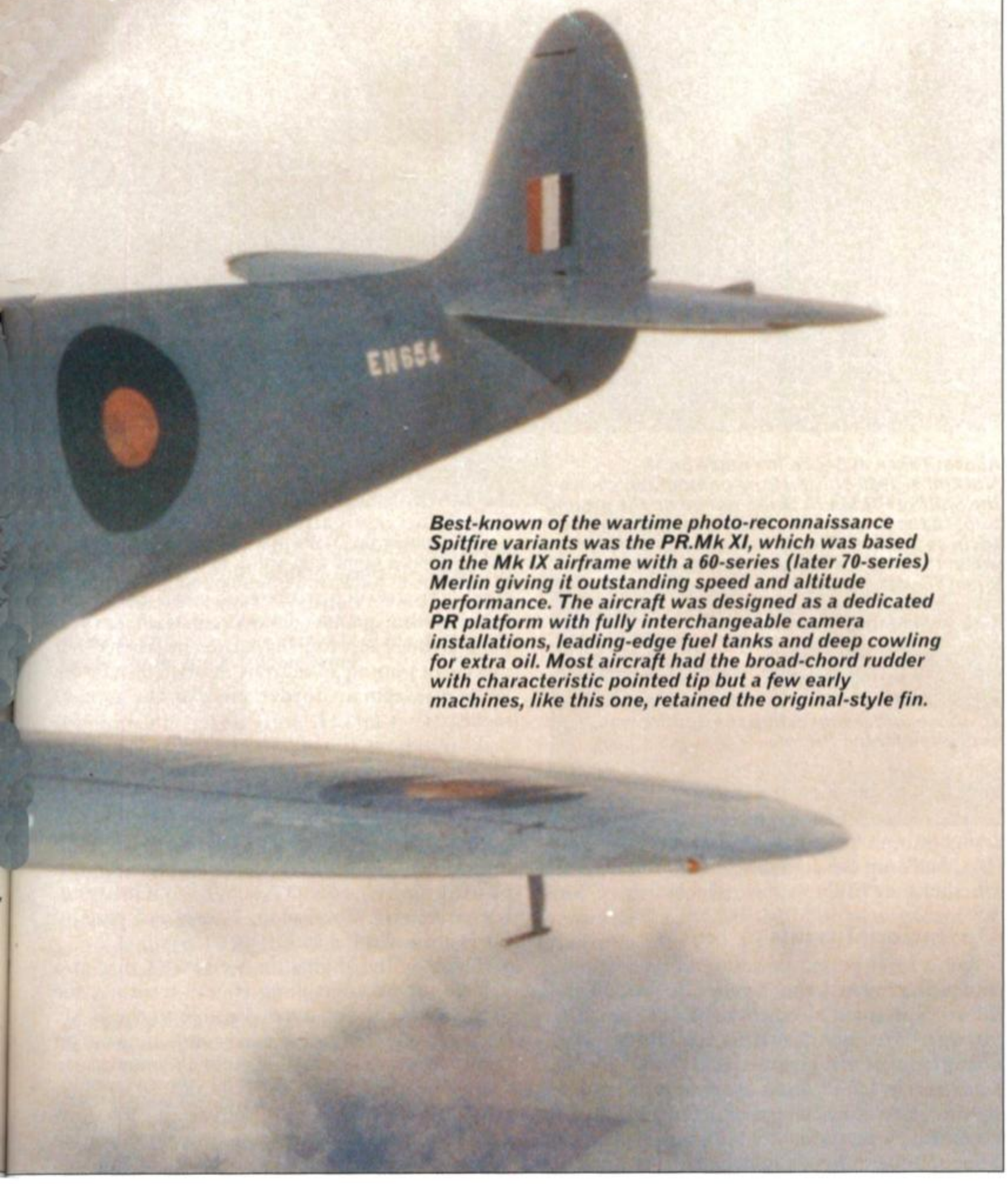
Longbottom's paper called for a lone, unarmed, high-speed high-flying reconnaissance aircraft that could dart into enemy territory, take the photographs and dart out, with a minimum of fuss and avoiding the defences whenever possible. In 1939 most long-range reconnaissance was flown by converted bomber aircraft equipped with a full defensive armament to fight their way to and from their targets. Yet, as Longbottom pointed out, the weight and drag penalty from the guns and turrets reduced the aircraft's performance and brought it within reach of the very defences it had to avoid to perform the mission effectively.

High-speed platform

Longbottom's proposal for a long-range reconnaissance aircraft centred on a high-speed single-seat fighter like the Spitfire, stripped of its armament and fitted with cameras and additional fuel tanks. He argued that the removal of the guns and ammunition boxes, the radio and other unnecessary equipment would reduce weight by 450 lb (204 kg). Since a reconnaissance Spitfire would not need a high rate of climb, it could take off weighing 480 lb (218

PR Spitfires

Conceived by a young flying officer as the most survivable means of getting photo-intelligence from within the enemy's heartland, the photo-reconnaissance Spitfire emerged as the most important strategic camera platform in the European theatre. It was born at a time when every Spitfire was desperately needed to defend Britain, yet through perseverance and persuasion the embryonic programme was allocated some precious aircraft. After the results of the first few missions, there were no more doubts.



Best-known of the wartime photo-reconnaissance Spitfire variants was the PR.Mk XI, which was based on the Mk IX airframe with a 60-series (later 70-series) Merlin giving it outstanding speed and altitude performance. The aircraft was designed as a dedicated PR platform with fully interchangeable camera installations, leading-edge fuel tanks and deep cowling for extra oil. Most aircraft had the broad-chord rudder with characteristic pointed tip but a few early machines, like this one, retained the original-style fin.

Illustrating the advances made in cameras in a short time, the photo above shows the city of Hamburg taken from a PR.Mk IF at about 30,000 ft in September 1940 with an 8-in (203-mm) lens, while that below shows the same area taken in July 1942 using a 36-in (70-mm) lens, revealing much greater detail. To confuse RAF bomb aimers part of the Alster Lake has been covered with rafts painted with streets and houses, and there is a fake railway bridge a few hundred yards north of the real one, which can be seen clearly in the earlier photograph.

kg) more than the fighter version. Thus, the aircraft had more than 900 lb (408 kg) of spare lifting capacity for the carriage of cameras and additional fuel. Longbottom calculated that a reconnaissance version of the Spitfire could carry three times more fuel than the fighter and it would have a range of 1,500 miles (2414 km).

The Air Ministry in London received Longbottom's paper with polite interest, although at first nothing was done to confirm or refute his arguments. The RAF was desperately short of modern fighters and, in particular, Spitfires. Every one of these precious machines was allocated to Fighter Command for the defence of the homeland. It would take more than a discussion paper from a junior officer, however persuasive its arguments, to get Air Chief Marshal Dowding to part with any.

In the meantime the war had begun, and it immediately became clear that the RAF photographic reconnaissance units were ill-equipped for operations over enemy territory. The slow Bristol Blenheims suffered severe losses from flak and fighters, even during shallow penetration missions.

Secret unit

Following strong representations from the Air Ministry, Air Chief Marshal Dowding reluctantly agreed to release a pair of Spitfires for modification as reconnaissance aircraft. Two Mk I fighters straight off the production line, N3069 and N3071, went to Heston Aircraft Ltd for modification. Also at this airfield, Commander Sidney Cotton was forming his highly secret reconnaissance unit with the cover name of 'The Heston Flight'. Appropriately, one of the first officers posted to assist with its formation was 'Shorty' Longbottom himself.

In the workshops at Heston the Spitfires had their armament and radios removed, and a vertically-mounted camera with a 5-in focal length lens was fitted in the empty gun bay in each wing. The airframes were cleaned up to give the last ounce of speed: the empty gun ports were sealed with metal plates, then all joints were filled with plaster of Paris and rubbed down to give a smooth exterior finish.

Cotton devised a novel colour scheme for the Spitfires. He had noticed that an aircraft observed from a distance and from below invariably appeared as a dark silhouette against the lighter sky background. He therefore reasoned that a light-coloured aircraft would be less visible than a dark one. Cotton had the Spitfires painted in a shade of pale green, which he called 'Camotint' and which he thought

Above: Taken at Seclin in France on 18 November 1939, this historic photograph shows the Spitfire PR.Mk IA being run up on the ground prior to the first reconnaissance mission by one of these aircraft. The aircraft was painted pale green to make it as inconspicuous as possible when viewed from below.

Left: Two of the personalities of the early PR Spitfire programme share a joke. On the left is Flying Officer Alistair Taylor, who flew the first low-level 'dicing' mission, while on the right is Flight Lieutenant Maurice 'Shorty' Longbottom, at whose initial suggestion the Spitfire was converted for the PR role.

would make them as inconspicuous as possible.

The initial reconnaissance Spitfires carried no additional fuel tank, and the other changes were kept to a bare minimum. The priority was to get the aircraft into the air on photographic missions as soon as possible. On paper, Longbottom's proposals seemed the best available, but only the acid test of war would prove whether they really were workable.

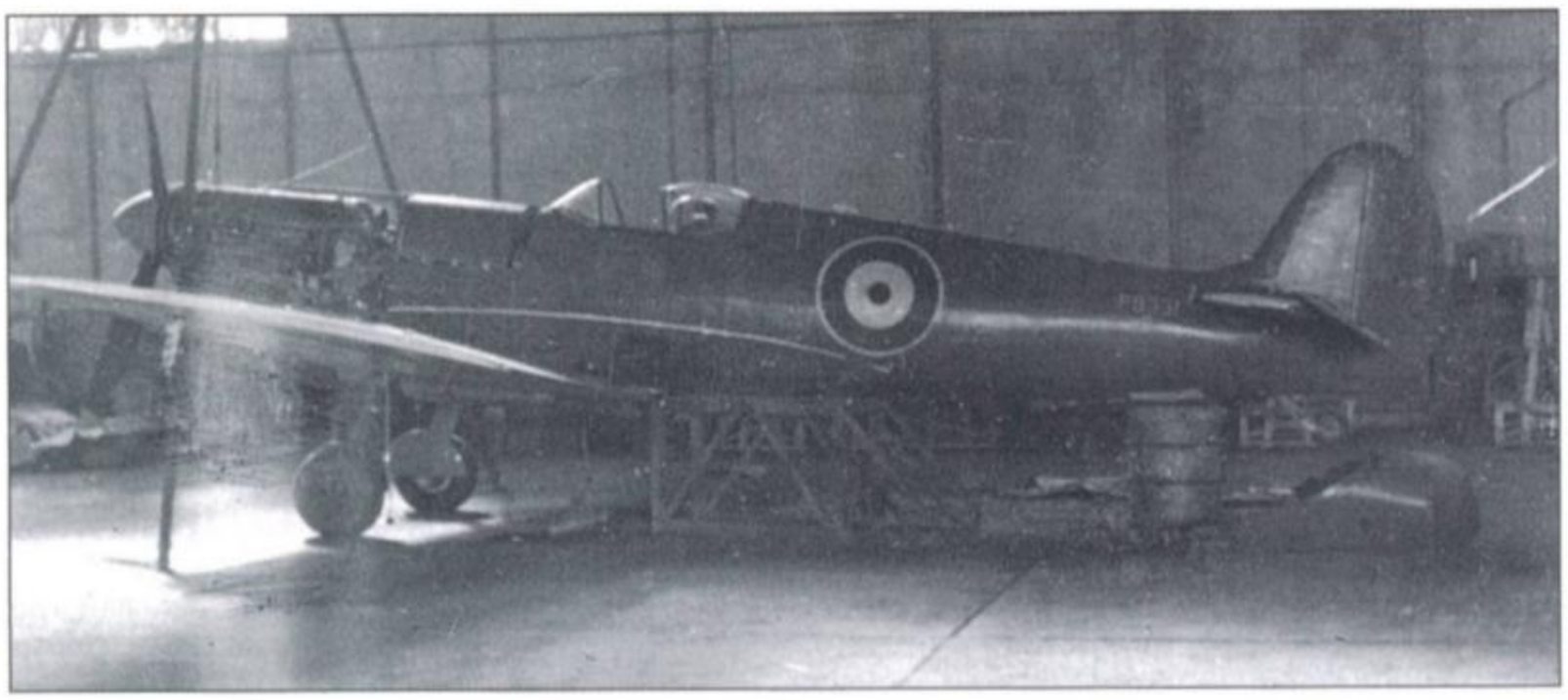
Operational trials

For a brief period in autumn 1939 Cotton's unit was renamed the 'Special Survey Flight'. Then, early in November 1939, the title changed yet again and to explain the odd colouring of its aircraft it became 'No. 2 Camouflage Unit'. Soon afterwards, one of the Spitfires flew to Seclin near Lille in France to commence operational trials. On 18 November, Longbottom, now a flight lieutenant, took off for the first-ever Spitfire reconnaissance mission. His target was the German city of Aachen and the fortifications around it. Cruising through the area at 33,000 ft (10058 m), Longbottom found the navigation more difficult than expected, however. After his return to Seclin his strips of photographs showed the Belgian side of the frontier south of Aachen. Longbottom quickly discovered where he had gone wrong, and four days later he carried out successful photographic runs as briefed over the Belgian-German border area to the east of Liege.

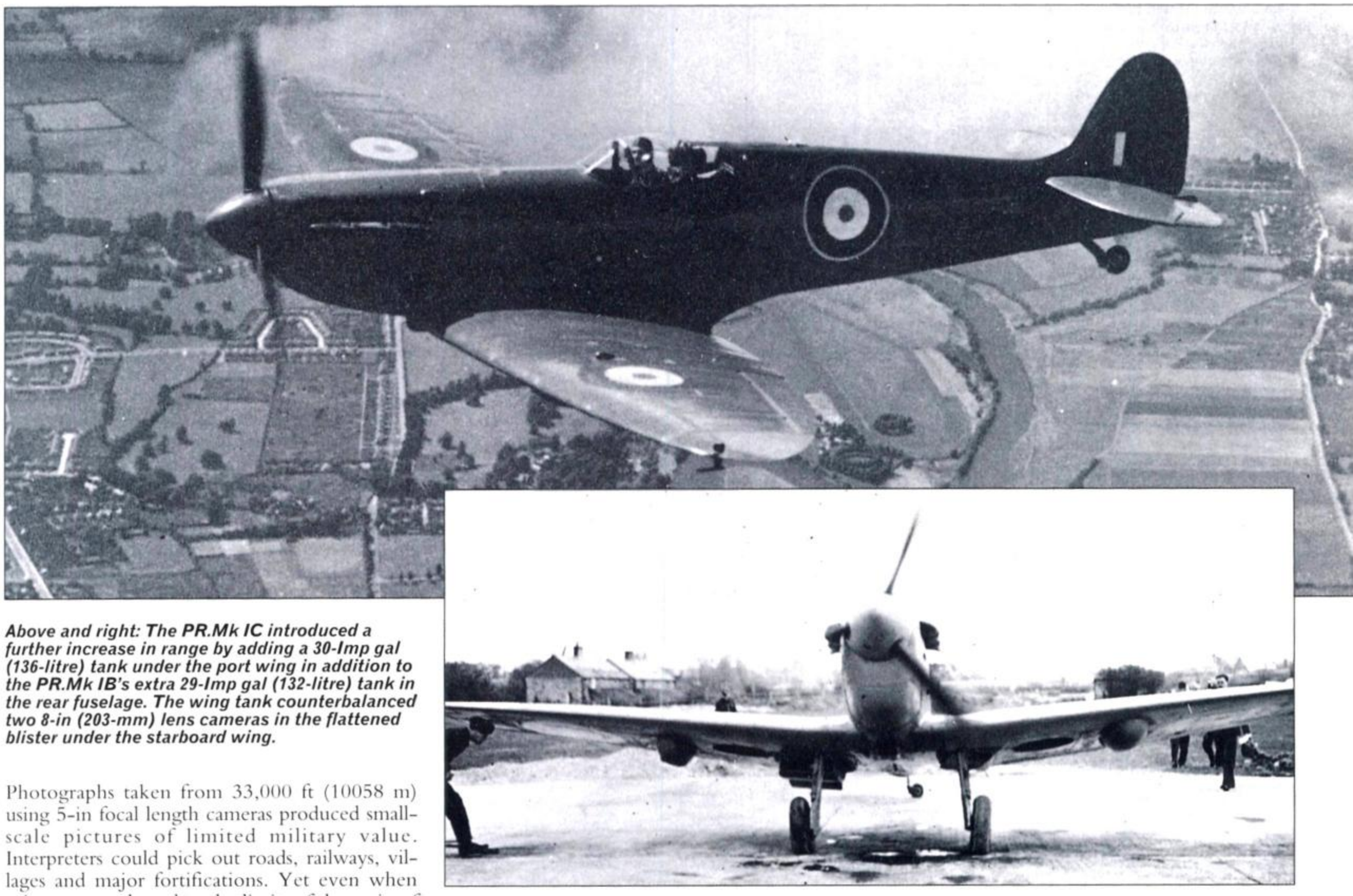
Throughout the six weeks following those initial flights, cloud cover prevented high-altitude photography of enemy territory. Then at the end of December the skies cleared, and both Spitfires took part in the next series of operations. The modified fighters returned with photographs of Aachen, Cologne, Kaiserslautern, Wiesbaden, Mainz and parts of the Ruhr industrial area.

These initial flights demonstrated that as a vehicle for photographing enemy territory, the Spitfire was the best type available to the RAF. Between the start of the war and the end of 1939, Blenheims had flown 89 reconnaissance sorties into German airspace, and 16 (18 per cent) had failed to return. Because of these losses, and the frequent harassment from defensive guns and fighters, only 45 of the Blenheim sorties (about half) had yielded useful photographs. In contrast, by the end of the year the two Spitfires had flown 15 sorties without a single loss, and 10 (two-thirds) of the sorties had yielded useful photographs. Of the five abortive Spitfire sorties, four were due to cloud cover at the target and only one was due to fighter interference. The flights proved the soundness of Longbottom's concept for high-performance unarmed reconnaissance operations, and ACM Dowding agreed to release a dozen more Spitfires for the new role.

These early reconnaissance flights showed that the Spitfire's high-altitude performance exceeded that of the available cameras.



Very few examples of the PR.Mk IB were produced, and photos are rare. This aircraft, P9331 operated by No. 212 Sqn in 1940, was captured by German forces after the Dunkirk evacuation.



Above and right: The PR.Mk IC introduced a further increase in range by adding a 30-Imp gal (136-litre) tank under the port wing in addition to the PR.Mk IB's extra 29-Imp gal (132-litre) tank in the rear fuselage. The wing tank counterbalanced two 8-in (203-mm) lens cameras in the flattened blister under the starboard wing.

Photographs taken from 33,000 ft (10058 m) using 5-in focal length cameras produced small-scale pictures of limited military value. Interpreters could pick out roads, railways, villages and major fortifications. Yet even when prints were enlarged to the limits of the grain of the film, troop positions and individual vehicles were invisible. For the Spitfire to exploit its full capabilities, better cameras were needed.

In January 1940 the first of the improved photographic reconnaissance Spitfires was ready for operations. It was designated the PR.Mk IB, and to distinguish it the earlier variant was renamed the PR.Mk IA. The new variant carried one 8-in (20.3-cm) focal lens camera in each wing, giving a one-third improvement in the scale of the photographs. Also, to increase its range, the PR.Mk IB carried an extra 29-Imp gal (132-litre) fuel tank in the rear fuselage. During the operations with PR.Mk IAs, Cotton's light green camouflage scheme was found unsuitable for operations at high altitude. Accordingly, the new Spitfires were painted in a medium-blue scheme later called 'PRU Blue'. In February 1940 'Shorty' Longbottom demonstrated the effectiveness of the new variant when, taking off from Debden in Essex, he returned with photographs of the important German naval bases at Wilhelmshaven and Emden.

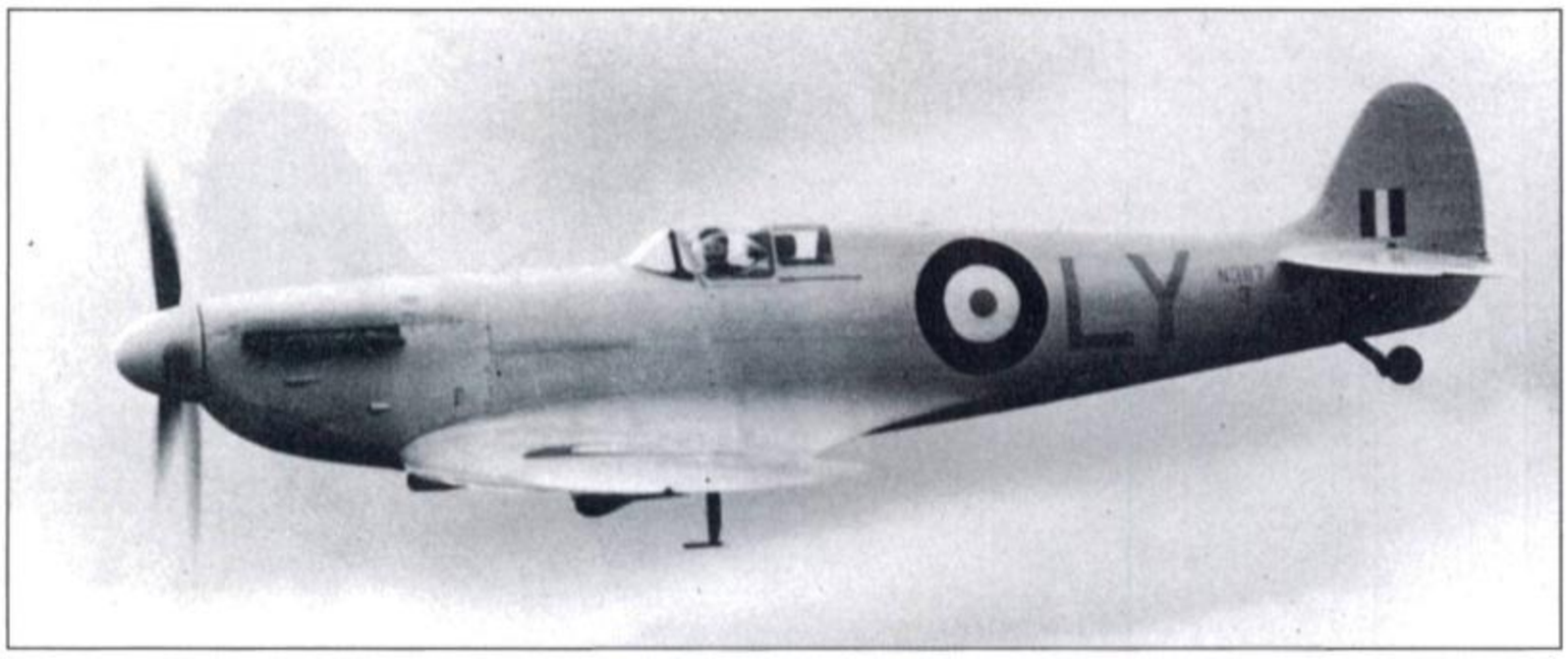
Also at this time Cotton's unit was renamed the Photographic Development Unit (PDU), the first title to reveal the true nature of its role. Early in 1940 the operations in France were reorganised and a new unit, No. 212 Squadron, was formed at Seclin to fly reconnaissance missions from there.

Unusually for a PR.Mk IC, this aircraft has the deepened engine cowling indicating fitment of an enlarged oil tank. It is seen with the front-hinging camera blister open under the wing. Pilot Officer Gordon Green flew this aircraft during his first reconnaissance mission, to St Nazaire, on 13 February 1941.

Greater range

In March 1940 a so-called 'long-range' reconnaissance version of the Spitfire appeared. Designated the PR.Mk IC, it had a 30-Imp gal (137-litre) blister tank under the port wing counterbalanced by a pair of 8-in (20.3-cm) lens cameras in a similar blister under the starboard wing. With a 29-Imp gal (132-litre) tank in the fuselage, this version carried 59 Imp gal (269 litres) more fuel than the fighter version.

On 7 April Longbottom took the prototype PR.Mk IC to Kiel, and brought back the first photographs of the port taken since the outbreak of war. The pictures showed numerous ships in harbour, and lines of Junkers 52 transport planes drawn up on the nearby airfield at Holtenau. Ignorant of the normal level of activity in the area, RAF photo interpreters could



N3117 is believed to have been the only example produced of the PR.Mk IE. Intended for low-altitude photography, the aircraft had a single oblique camera under each wing pointing outwards and downwards.

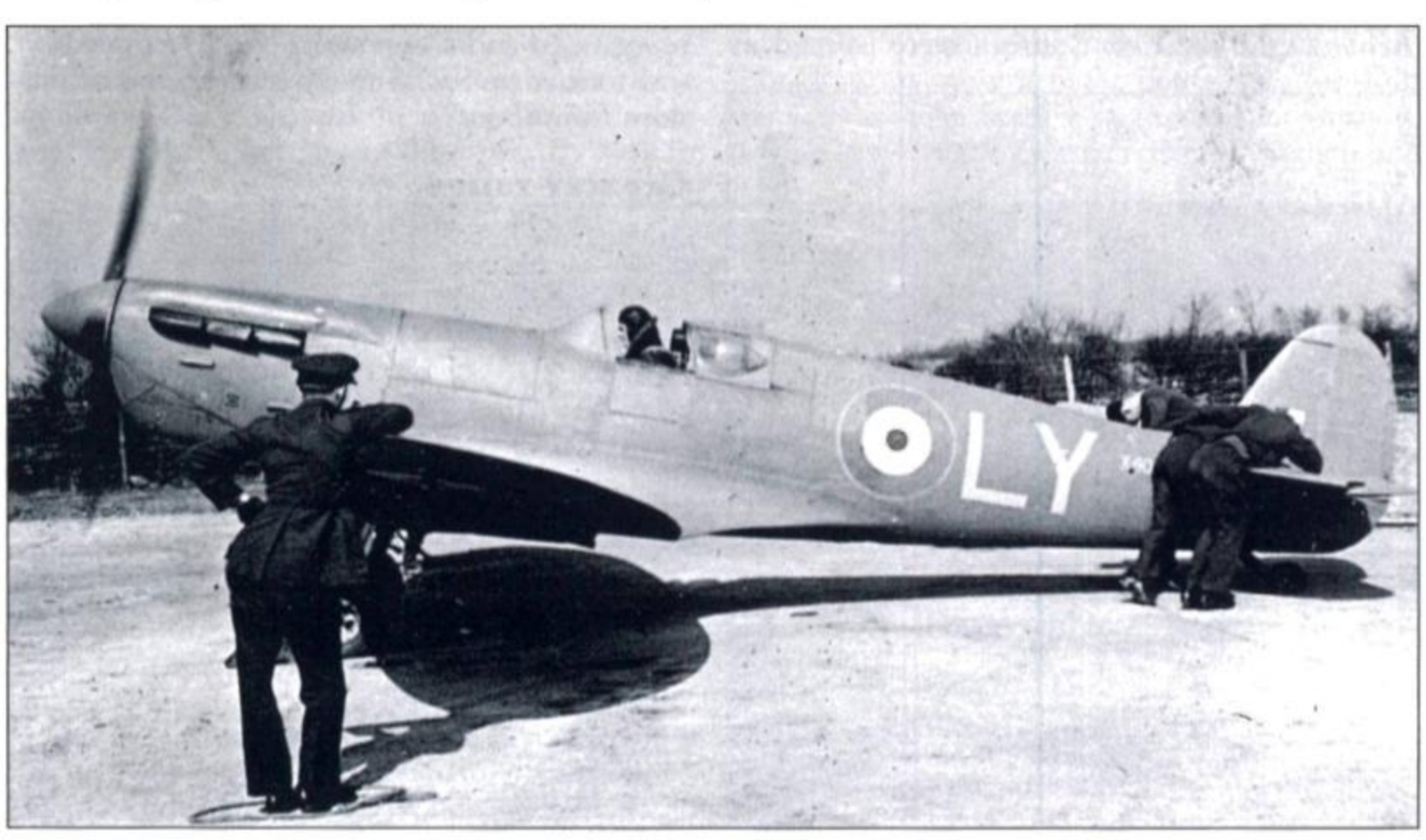
In July 1940 Wing Commander Geoffrey Tuttle became commander of the PRU at Heston, and he led the unit through the Battle of Britain when it played close attention to German invasion preparations. He is seen here receiving the Distinguished Flying Cross from King George VI in August 1940 in recognition of the valuable work of the unit.

draw no useful conclusions from these findings. Two days later German troops invaded Denmark and Norway, and the significance of the concentrations suddenly became clear. The incident highlighted an important lesson of aerial photography that dated from World War I; by itself, one set of photos tells little. Only with repeated photography of an area can the interpreters determine whether a level of activity, or lack of it, is significant.

Just over a month later, on 10 May 1940, German forces launched their powerful Blitzkrieg attack on France, Holland and Belgium. During the hectic weeks that followed No. 212 Squadron flew numerous sorties, charting the relentless progress of the German Panzer columns through France. The latter stormed towards the English Channel, slicing the Allied forces in two. Intelligence from the Spitfire's photographs could do nothing to avert defeat. However, by keeping Allied commanders aware of the growing peril, they allowed preparations to begin in time for the successful evacuation of large numbers of troops from Dunkirk. It is no exaggeration to say that the reconnaissance Spitfires played a major part in preventing the defeat from turning into a disaster.

When it was clear that its position in France was no longer tenable, No. 212 Squadron withdrew to England. The unit then disbanded and the surviving aircraft and personnel were incorporated into the PDU at Heston.

The PR.Mk IF (above) looked very much like the PR.Mk IC, but to give yet further range the starboard camera blister was replaced by another 30-Imp gal (136-litre) fuel tank, the displaced cameras being moved to vertical mounts in the rear fuselage. The deep engine cowl necessary to accommodate the larger oil tank is clearly displayed in the photograph (below) of Alistair Taylor running up prior to take-off, with ground crew holding back the aircraft.

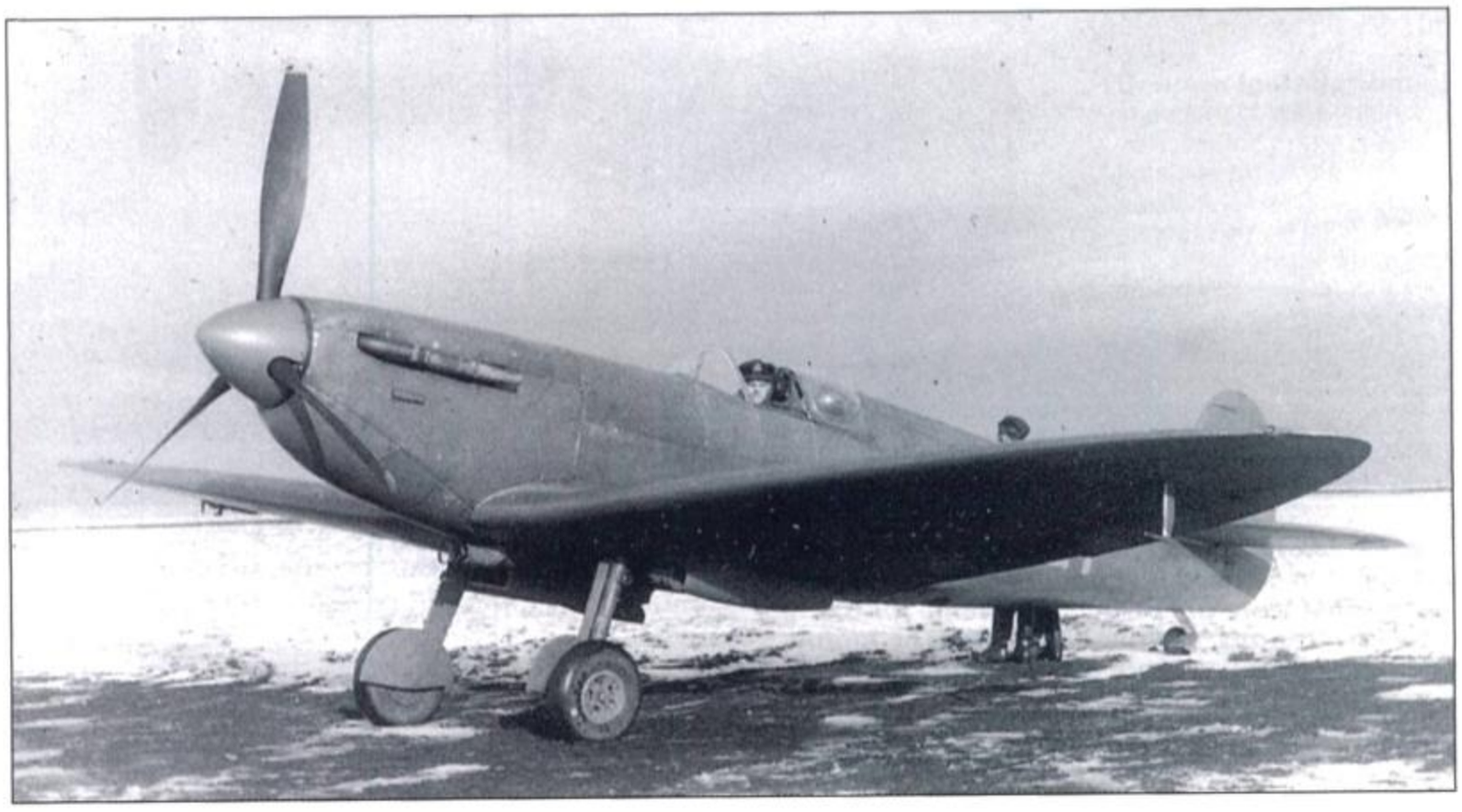


Oblique cameras

Thus far, the reconnaissance Spitfires had flown all of their missions at medium or high altitude, and photographed their targets from vertically above. Most photography would continue to be done that way but another technique, using an oblique-mounted camera, allowed close-up shots of small targets or photography below a low cloud base.

The first Spitfire to be fitted with the fixed oblique camera installation was the PR.Mk IE (the PR.Mk ID, the next variant in alphabetical order, will be discussed later in this account). The PR.Mk IE had a camera under each wing, pointing outwards at right angles to the line of flight and 15° below the horizontal. Streamlined bulges covered the mountings. The new camera installation proved its worth on 7 July 1940, when Flying Officer Alistair Taylor set out in the PR.Mk IE to photograph shipping in Boulogne harbour. The atrocious weather would have precluded photography with vertically mounted cameras; the cloud base was down to 700 ft (213 m), in heavy rain. Flying outside the breakwater at an altitude of about 300 ft (100 m), Taylor flew a run taking photographs with his starboard camera. Then he turned around and flew a second run using the port camera. Low altitude photography, nicknamed 'dicing' because of the risks involved, became an important additional role for the reconnaissance Spitfires.

Left and below: The Spitfire PR.Mk ID carried no external bulges, and its external shape was little different to that of the Mk I fighter. Internally the wing structure was quite different. Early PR.Mk IDs carried an additional 114 Imp gal (518 litres) of fuel in the wing leading edges, later enlarged to hold 133 Imp gal (605 litres). The addition of these tanks gave rise to the unusual sight of a Spitfire being refuelled almost at the wingtip.



Also in July 1940, the Photographic Development Unit underwent yet another name change. It became the Photographic Reconnaissance Unit (PRU) and at the same time Wing Commander Geoffrey Tuttle replaced Sidney Cotton as its commander. The changes of name and commander made no difference to the way the unit operated, however.

At the end of July another Spitfire reconnaissance variant appeared, the 'super-long-range' PR.Mk 1F. This aircraft carried a 30-Imp gal (137-litre) blister tank under each wing and a 29-Imp gal (132-litre) tank behind the pilot, giving 89 Imp gal (405 litres) more than the fighter version. To provide additional oil for the longer flights, there was a larger tank beneath the engine. The cameras, mounted in the rear fuselage, initially comprised two 8-in (20.3-cm) lens cameras later replaced with 20-in (50.8-cm) focal lens units. The additional fuel gave the PR.Mk 1F a radius of action about 100 miles (160 km) greater than that of the Type C.

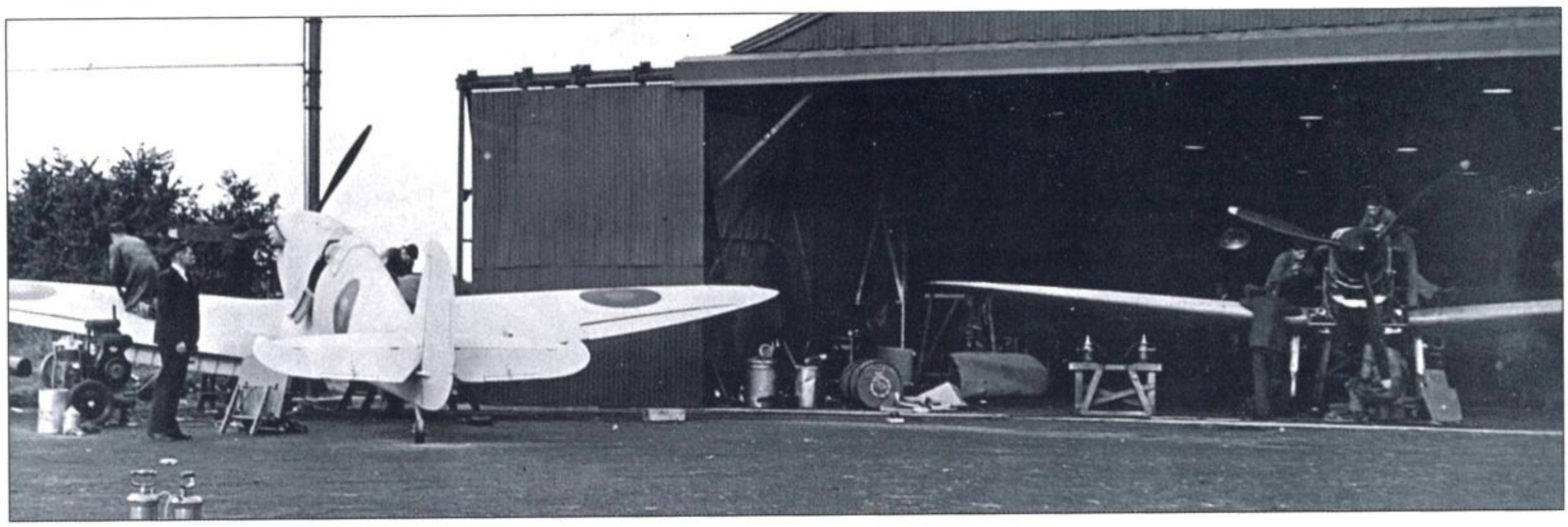
After a wait for ideal meteorological conditions the new variant would fly the RAF's first photographic sortie to Berlin, in March 1941. In the summer and autumn of 1940, the reconnaissance Spitfires kept a close watch on German preparations for the invasion of Britain. The PRU, about the size of a normal RAF fighter squadron, achieved far more than any other unit of equivalent strength. On each day when the weather allowed, its Spitfires sallied forth to photograph ports along the Channel coast, observing the increasing number of barges and other ships at each. During this period the British operation to decrypt German signals traffic, codenamed Ultra, had started to produce a stream of useful information on German plans and deployments. Unknown to the pilots of the reconnaissance Spitfires, many of their sorties were targeted on the basis of Ultra decrypts. Once a reconnaissance aircraft had flown over an area, anything of an intelligence nature that might have shown up in its photographs could reasonably be ascribed to that source. It was an essential move to keep secret the success of the cipher breakers.

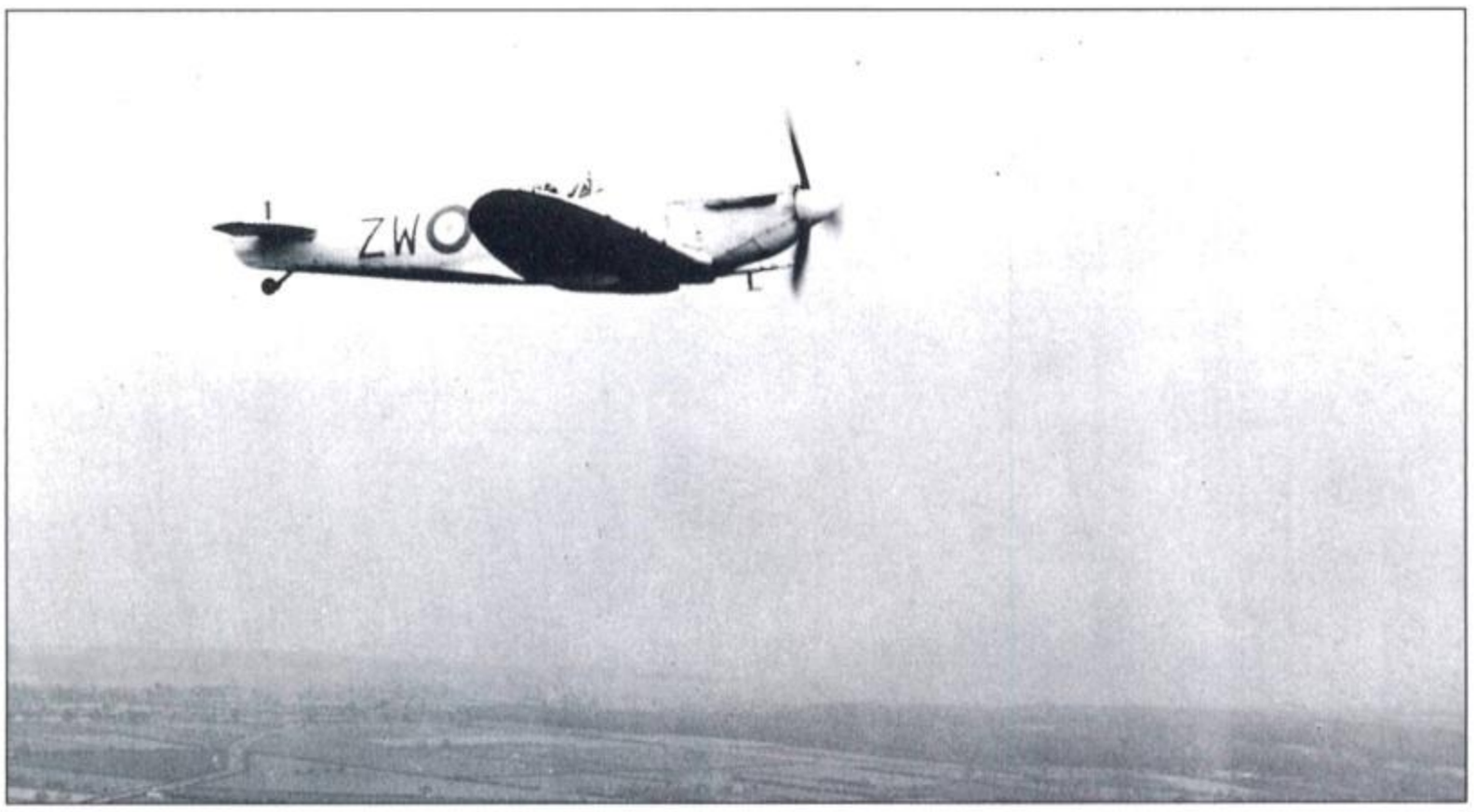
The Luftwaffe losses during the great air battle on 15 September 1940 convinced Hitler that the RAF would not be defeated before the weather broke in the autumn. He ordered the postponement of the invasion. On 20 September a reconnaissance Spitfire returned from Cherbourg with the first photographic evidence of the German change of plan. Compared with those taken earlier, its photographs revealed that five destroyers and a torpedo boat had left the port. During the weeks that followed, successive sorties showed progressively fewer ships and barges in the invasion ports. The threat to Britain had passed.

PR.Mk IVs (previously PR.Mk IDs) are seen around the small assembly hangar at Henley-on-Thames, the aircraft having been built in nearby Reading and Caversham. From 1941 this plant, part of the dispersed manufacturing complex, was the main source of specialised reconnaissance Spitfires.

To the Baltic and the Mediterranean

The 'long-range' and 'extra-long-range' versions of the Spitfire opened new vistas for photographic reconnaissance, yet the modified fighter could do even better. Supermarine redesigned the aircraft's wing to take a huge additional fuel tank holding 114 Imp gal (518 litres). It was a more difficult modification than the others, since the new wings had to be hand-built by craftsmen. In October 1940 the first two Spitfires with the wing leading-edge tanks were ready for operations. The variant, the





The PR.Mk IG was a low-altitude version intended to be used just underneath the cloud base. Most wore the pale pink scheme for the 'dicing' missions, although this could be highly conspicuous when there was no cloud cover.

Above: A pink Spitfire PR.Mk IG is prepared for a low-altitude 'dicing' mission from St Eval in Cornwall in 1941, this base being used as it was close to the major harbour at Brest.

PR.Mk ID, became known as the 'extra-super-long-range' version. With a 29-Imp gal (132-litre) tank in the rear fuselage, it had a total internal fuel capacity of 228 Imp gal (1037 litres) – two and a half times more than the Mk I fighter. In the rear fuselage the PR.Mk ID carried two 8-in (20.3-cm) or two 20-in (50.8-cm) focal length cameras.

The additional tankage gave a dramatic increase in the area of German-held territory where the reconnaissance Spitfires could operate. On 29 October 1940 a PR.Mk ID photographed the port of Stettin on the Baltic (now Sczecin in Poland) and returned after five hours and 20 minutes airborne. Other remarkable missions followed in rapid succession: to Marseilles and Toulon in the south of France, and to Trondheim in Norway.

When carrying its full load of fuel, the PR.Mk ID was difficult to handle. Flight Lieutenant Niel Wheeler explained: "You could not fly it straight and level for the first half hour or hour after take-off. Until you had emptied the rear tank, the aircraft hunted the whole time. The centre of gravity was so far back that you couldn't control it. It was the sort of thing that would never have got in during peacetime, but war is another matter." Once its rear tank was empty, however, the Spitfire's pleasant handling characteristics returned.

Cloud base special

The final reconnaissance variant based on the Spitfire Mk I was the Type G which, like the PR.Mk IE, was optimised for the low-altitude photographic role. This version retained the fighter's normal armament of eight 0.303-in machine-guns, to provide a self-defence capability if it encountered enemy fighters. The PR.Mk IG carried a 29-Imp gal (132-litre) fuel tank behind the pilot. The three-camera installation in the rear fuselage comprised one obliquely mounted camera, and a 14-in (35.6-cm) and a 5-in (12.7-cm) lens camera both mounted vertically. The Type G was intended to photograph targets from just below the cloud base, wherever that happened to be. The oblique camera was for photography below 2,000 ft (610 m), the 5-in (12.7-cm) lens vertical camera was for use between 2,000 and 10,000 ft (610 and 3050 m) and the 14-in (35.6 cm) lens was for photography from above 10,000 ft. A few PR.Mk IGs were painted in normal fighter camouflage, but the majority

A few PR.Mk IGs operated in standard fighter camouflage, this example serving with No. 140 Sqn in 1941. The squadron had been formed at Benson in September 1941 out of 1416 Flt. An unusual feature of the G was that the oblique camera was angled slightly backwards to reduce blur as the aircraft flew past targets at high speed. This necessitated the bulged camera blister on the side of the fuselage.

A close-up of a pink PR.Mk IG shows the oblique camera installation and the side bulges on the canopy fitted as standard to early PR Spitfires.

Supermarine Spitfire PR.Mk IG No. 1 PRU St Eval, 1941

Powerplant
A mix of powerplants was fitted to the Mk I-derived PR Spitfires. The Type As and Bs were completed with Merlin IIIs, the Type C initially flew with Mk II and XII engines while the Type D was designed to take the Merlin 45/46. The Type G/Mk VII initially flew with the Merlin III, although most were re-engined with Merlin 45s to gain the extra power.

Cockpit canopy
Bulged blisters on the canopy sides gave improved vision to the rear and below. A small cross in a circle, etched on the canopy blister on the port side, served as a sight for the oblique camera.

Camera installation
The camera installation was located in the rear fuselage aft of the additional fuel tank. The aircraft carried a 5-in (12.7-cm) focal length camera in an oblique mounting facing to port. In addition, the aircraft carried two vertical cameras, one with a 5-in and one with a 14-in (35.6-cm) lens, in the rear fuselage below the oblique camera.

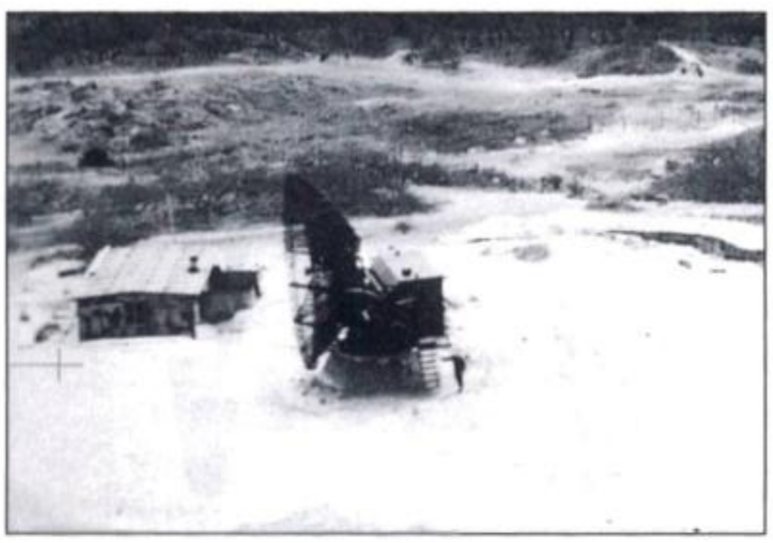
Armament
For self-defence, the aircraft retained the fighter's armament of eight 0.303-in (7.62-mm) Browning machine-guns mounted in the standard 'A' wings.

This aircraft, R7059, was built as a Mk I fighter and as such it made its maiden flight from Eastleigh in February 1941. The following month it went to Heston Aircraft Ltd for conversion to the low-altitude reconnaissance role, as a PR.Mk IG. In May it was delivered to No. 1 Photographic Reconnaissance Unit and formed part of the detachment at St Eval, Cornwall, engaged on flying hazardous 'dicing' missions as part of the continuous daily watch on the German battle cruisers in Brest harbour. Soon afterwards, following the rationalisation of the designations of reconnaissance Spitfires, this variant became known as the PR.Mk VII. In June 1942 the aircraft was transferred to No. 8 Operational Training Unit at Fraserburgh, where new reconnaissance pilots were trained. The aircraft was written off in June 1943, following a fire and forced landing.

Colour scheme and markings
This Spitfire carried the very pale pink/off-white colour scheme developed by the PRU for aircraft photographing targets from below a layer of cloud. During the early war period the PRU had a free hand to experiment with paint schemes, as evidenced by the non-standard colours used in the national markings and the positioning of the roundels above the wings. The aircraft carries the 'LY' code letters of No. 1 Photographic Reconnaissance Unit (earlier this code had identified the aircraft of the PRU). In conformity with the normal practice in these units, the Spitfire carries no individual identification letter.

Fuel
The two main fuel tanks, with a total capacity of 85 Imp gal (386 litres), were mounted behind the engine. In addition, this variant carried a 29-Imp gal (132-litre) tank in the rear fuselage immediately behind the cockpit.

Radar sets were typical targets for the Spitfire's oblique cameras, close-up shots being required to determine the antenna arrangements. This image depicts the Würzburg radar station at St Bruneval near Le Havre, photographed by Tony Hill on 4 December 1941. The picture led to a raid by British paratroops who captured the radar and returned to England with vital parts from it.



Another famous photograph taken by Tony Hill shows the Giant Würzburg night-fighter control radar at Domberg on the Dutch island of Walcheren, taken on 2 May 1942. One of the operators stands helplessly by the ladder to the cabin, providing a ready-made human yardstick for British intelligence officers when they came to analyse the picture.

Flight Lieutenant Tony Hill was one of the most distinguished 'dicing' pilots of No. 1 Photographic Reconnaissance Unit. After promotion to squadron leader, he was killed in October 1942 during a hazardous mission deep inside France.

were painted overall in a very pale shade of pink, barely off-white, to conceal them when seen against a cloud background. If there was insufficient cloud the almost-white aircraft was vulnerable to fighter attack from above, and pilots had orders to abandon the mission if conditions were unsuitable.

In November 1940 the Photographic Reconnaissance Unit was redesignated No. 1 Photographic Reconnaissance Unit, to distinguish it from No. 2 Photographic Reconnaissance Unit then forming in the Mediterranean theatre. Soon afterwards, No. 1 PRU moved from Heston to Benson near Oxford, a permanent RAF airfield that would remain its base for the rest of the war.

Above: Another distinguished PR pilot was Flight Lieutenant Eric le Mesurier. Visible on the canopy bulge is the sighting cross for the starboard-facing oblique camera.

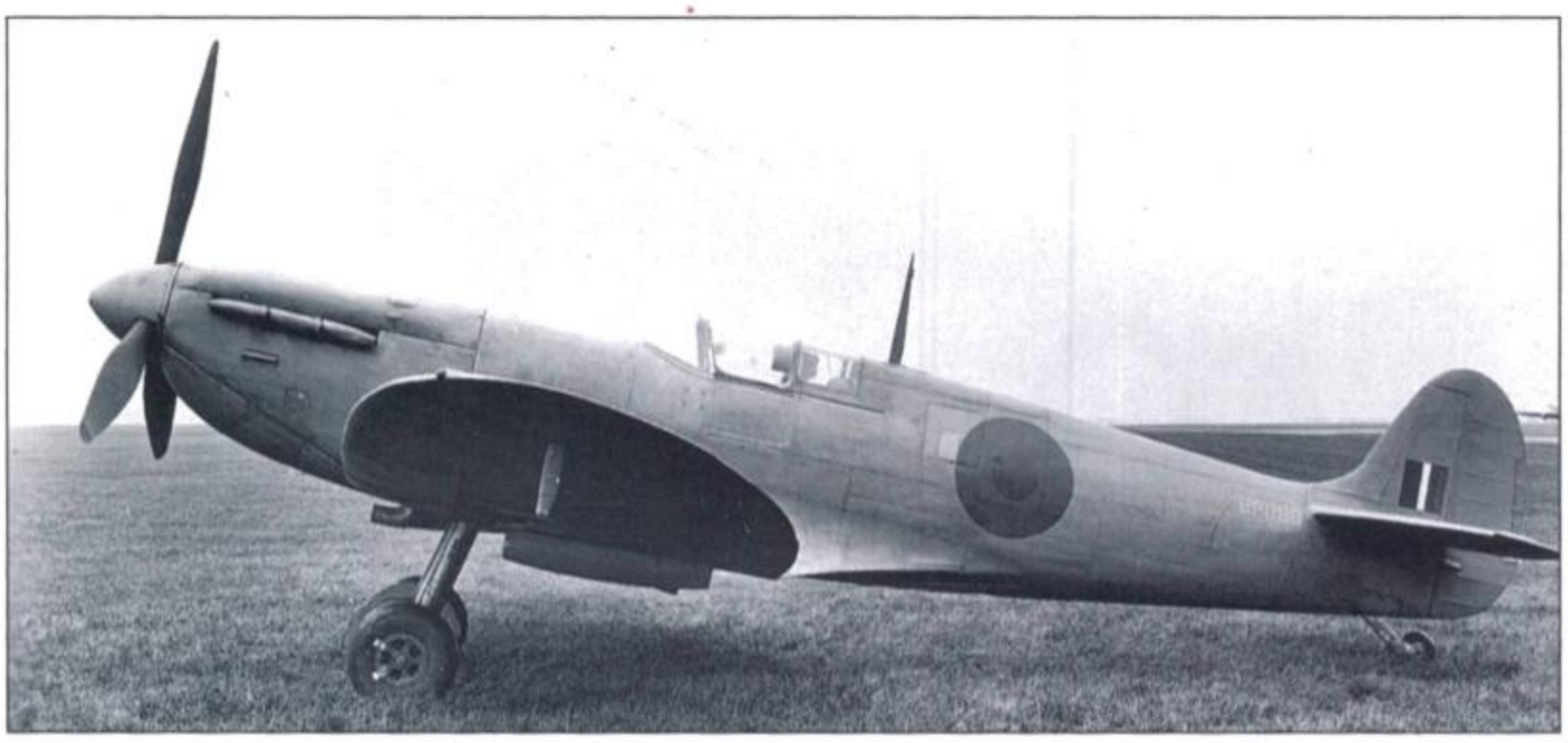
Spitfire pilots engaged in lone flights deep into enemy territory had to contend with a range of problems that went with their specialised role. Pilot Officer Gordon Green flew operations with the PRU from February 1941 and he recalled: "During the early [photographic reconnaissance] missions there was no such thing as cockpit heating in our Spitfires. For the high-altitude missions we wore thick suits with electrical heating. Trussed up in our Mae West and parachute, one could scarcely move in the narrow cockpit of the Spitfire. When flying over enemy territory one had to be searching the sky the whole time for enemy fighters. On more than one occasion I started violent evasive action to shake off a suspected enemy fighter, only to discover that it was a small speck of dirt on the inside of my perspex canopy!

"A big worry over enemy territory was that one might start leaving a condensation trail without knowing it, thus pointing out one's position to the enemy. To avoid that we had small mirrors fitted in the blisters on each side of the canopy, so that one could see the trail as soon as it started to form. When that happened one could either climb or descend until the trail ceased. If possible, we liked to climb above the trail's layer because then fighters trying to intercept us had first to climb through the trail's layer and could be seen in good time."

During 1941 the *ad hoc* system of designations for reconnaissance Spitfires underwent a rationalisation. The Type C was redesignated the PR.Mk III; the Type D became the PR.Mk IV; the Type E became the PR.Mk V; the Type F became the PR.Mk VI; and the Type G became the PR.Mk VII. By then the surviving Type As and the Type Bs had all been modified into later variants. Also during the year the reconnaissance Spitfires were fitted or retrofitted with the Merlin 45 series engine as fitted to the Mk V fighter variant. No change in designation followed this change, however.

Watching the German fleet

Early in 1941 the German battle cruisers *Scharnhorst* and *Gneisenau* and the heavy cruiser *Admiral Hipper* put into harbour at Brest in western France, after a destructive foray against convoys in the north Atlantic. If these warships put to sea the Admiralty needed to know as soon as possible, so it could position naval forces to meet the threat. As a result, No. 1 PRU received a top-priority task to photograph the port three times each day. To provide the best chance of meeting this requirement, whatever the weather, pairs of Spitfires took off from St Eval in Cornwall and flew to Brest independently: a blue-painted Type C or Type F at high altitude to photograph the port if the skies were sufficiently clear, and a pale pink aircraft to photograph it if there was cloud cover. On this assignment, six-tenths' cloud was termed the 'no-man's land' figure. It was too much to allow much chance of successful photography



The PR.Mk IV was built in some numbers. There were three standard camera installations: the 'W' had two F8 20-in (508-mm) cameras in a split-vertical arrangement, the 'X' had two F24 14-in (356-mm) cameras in a split vertical with a single F24 8-in (203-mm) or 14-in oblique camera, while the 'Y' had a single F52 36-in (914-mm) camera mounted vertically. The 'W' and 'Y' installations had hot air heating, while the 'X' was heated electrically.

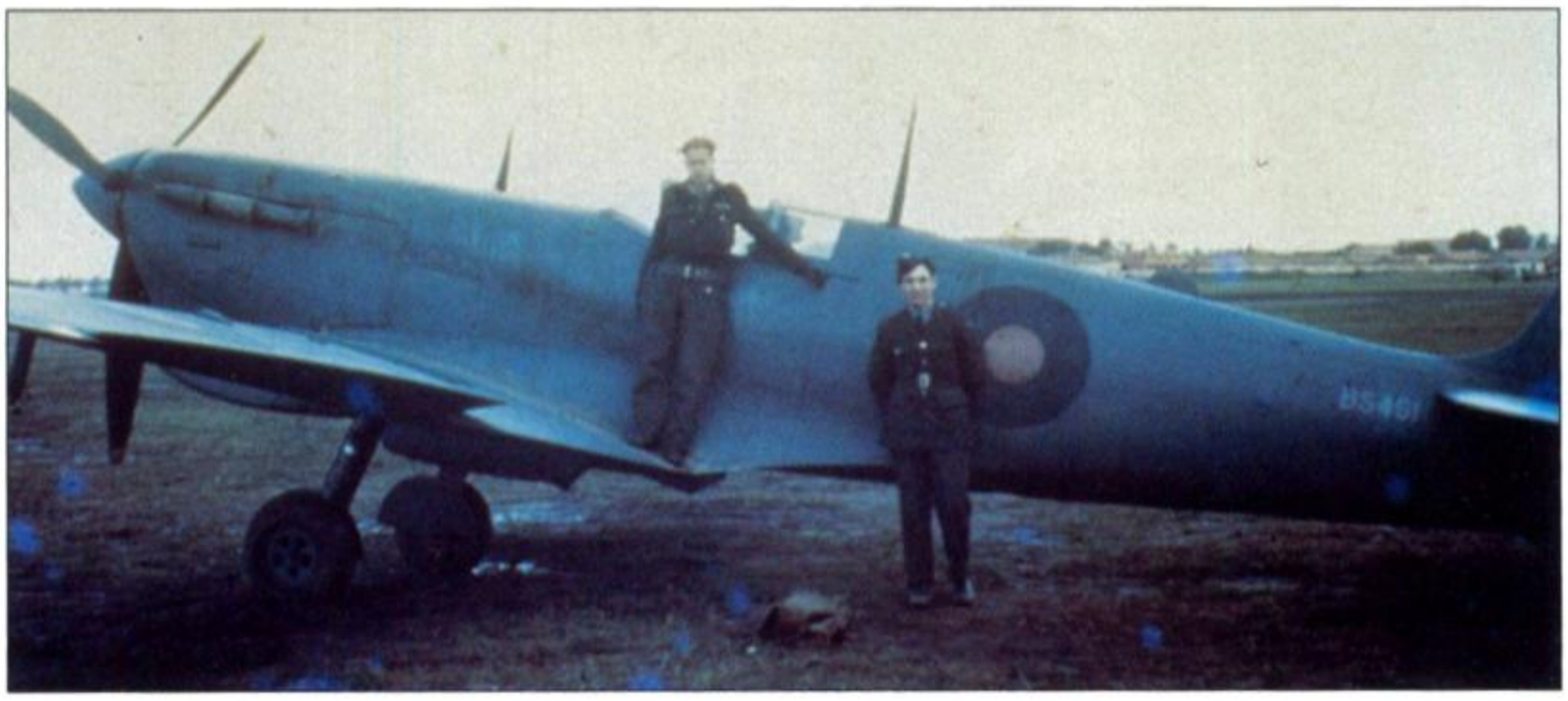
from high altitude, and too little to conceal a Spitfire at low altitude.

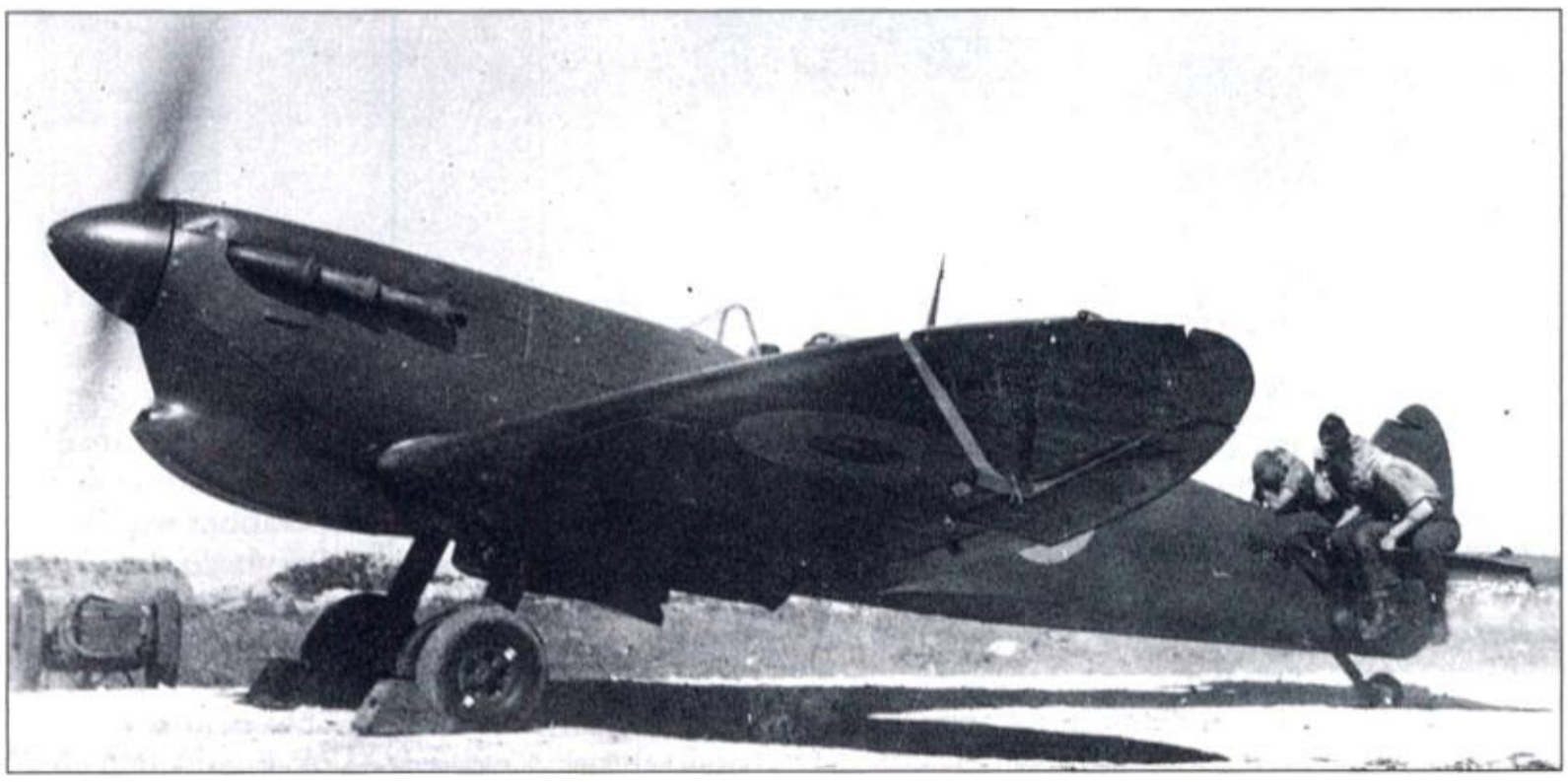
The fighter units and flak batteries defending Brest quickly became aware that regular flights were being made to photograph the harbour. Several Spitfires were lost and those who survived had to employ every possible stratagem. Gordon Green explained: "During the early [photographic reconnaissance] missions to cover Brest we lost about five pilots fairly quickly. After the first couple had failed to return the Flight Commander, Flight Lieutenant Keith Arnold, asked Benson to send some reserve pilots. They duly arrived. Both took off for Brest that evening and neither came back. That was a very sobering incident.

Get back at all costs

"The important thing with any photographic mission was to take the photos if one could, and get them back to base. As the 'boss' of PRU, Wing Commander Geoffrey Tuttle, often used to say, 'I want you to get home safely not just because I like your faces, but because if you don't the whole sortie will be a waste of time!' So it was no use trying to play hide and seek with the Luftwaffe. If one had lost surprise during the approach to a heavily defended target, the best thing was to abandon the mission. One could go back another time when things might be better.

"Looking back at my time with the PRU I get a lot of satisfaction from the knowledge that although I played my part in the war, I never had to fire a shot in anger. In one sense we in the reconnaissance business had things easy. All the time it was impressed on us: bring back the photographs or, if you can't, bring back the aeroplane. An infantryman taking part in the Battle of Alamein could not suddenly decide, 'This is ridiculous, I'm going home!' He just had to go on. But if we thought we had lost the element of surprise we were not only permitted to turn back, we were expected to do so. On the other hand, there were times when I knew real fear. When one was 15 minutes out from Brest on a low-altitude sortie, one's heart was beating away and as the target got nearer one's mouth got completely dry. Anyone who was not frightened at the thought of going in to photograph one of the most heavily defended targets in Europe was not human.





Spitfire PR.Mk IVs served with distinction in North Africa. The example above is on detachment to the theatre with No. 542 Sqn, while the aircraft below is from No. 2 PRU, which was formed in June 1941 at Heliopolis in Egypt. Both have the cumbersome tropical filters fitted.

"Whenever it was possible to photograph a target, flak could engage us: if we could see to photograph they could see to open up at us. But throughout my time as a reconnaissance pilot my luck held. I never once saw an enemy fighter, nor was my aircraft ever hit by flak. Indeed, only once during the time we were flying those missions over Brest did one of our aircraft come back with any damage, and that was minor. It was all rather like a fox hunt – either the fox got away unscathed or else it was caught and killed. There was rarely anything in between."

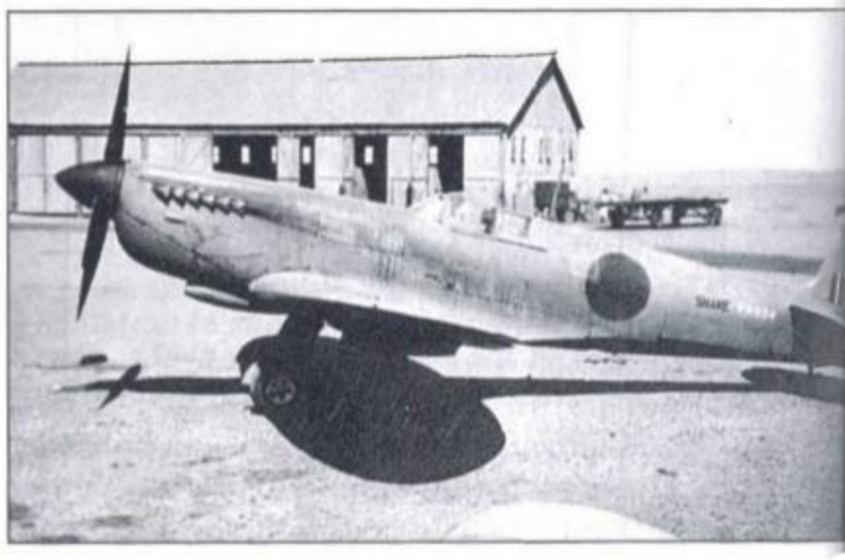
As the war progressed, the RAF reconnaissance force faced increasing demands to provide photographs of targets deep inside occupied Europe. To meet these requirements, No. 1 PRU underwent a steady increase in size. By May 1942 the unit had six flights of Spitfires with a total of 53 aircraft, and two flights of Mosquitos with 12 aircraft. In the following October the Spitfire and Mosquito flights of No. 1 PRU were reorganised into four squadrons. The two flights of Mosquitos were incorporated into No. 540 Squadron, while the six flights of Spitfires were divided between Nos 541, 542 and 543 Squadrons.

High-performance Spitfire

Also during 1942, the German air defences steadily improved with the deployment of the latest Bf 109G and Fw 190A fighters. As a result, the reconnaissance Spitfire units suffered mounting losses. The obvious answer was to produce a higher-performance reconnaissance aircraft powered by the Merlin 61 engine fitted to the Mk IX fighter. The new variant, the

This is another tropicalised Spitfire PR.Mk IV, incorporating the neater 'Aboukir' filter developed by 103 Maintenance Unit. The aircraft was dispatched to the Middle East on board the* Amot Elkerk*, disembarking at Takoradi on the Gold Coast for reassembly and onward flight to Egypt.

Above: This PR.Mk XI was used for a variety of test work associated with the programme. It was later converted to serve as a fast mail carrier.



Fifteen Mk IX fighters became PR.Mk IXs to fill an urgent need for high-performance camera platforms before the Mk XI became available. The aircraft had guns removed and cameras fitted, but retained the fighter's standard fuel tankage, relying instead on a 90-Imp gal (409-litre) drop tank for extra range.

Pictured in Egypt during transit to Southeast Asia is PR.Mk XI PA934. The 'Snake' designation indicates that the aircraft has been modified for operations in the humid Far East.

Spitfire PR.Mk XI, combined the strengthened airframe of the Mk VIII fighter with the wing fuel tank of the PR.Mk IV.

As an interim measure until the PR.Mk XI became available, 15 Mk IX fighters underwent modification for the reconnaissance role. Designated PR.Mk IXs, these aircraft had the armament removed and a pair of vertical cameras installed in the rear fuselage. The version had no extra internal fuel tankage, and during operations it usually flew with a 90-Imp gal (409-litre) drop tank under the fuselage. No. 541 Squadron at Benson received the first PR.Mk IXs in November 1942. Although the PR.Mk IX was limited to operations over western Europe, it restored to the force the ability to photograph defended targets without incurring serious losses. In December 1942 the first Spitfire PR.Mk XIs began coming off the production line. The new variant could reach altitudes above 40,000 ft (12190 m), 10,000 ft (3058 m) higher than any previous reconnaissance version. The Mk XI replaced all other unarmed versions of the Spitfire in front-line reconnaissance units, and 471 examples were built. For more than a year after the variant entered service, it was almost immune to fighter interception while it was flying at high altitude.

If one of these aircraft was lost, it was usually after it had descended either due to a technical failure or because of the pilot needed to go below cloud to take his photographs.

With the 8th Air Force to Berlin

During the autumn of 1943 the US 8th Air Force in Great Britain received a dozen Mk XIs. These formed the equipment of the 14th Photo Squadron, 7th Photographic Group, based at Mount Farm near Oxford. The unit's role was to take pre-strike and post-strike photographs of targets for US heavy bombers. Major Walt Weitner, commander of the 14th, flew his most memorable mission on 6 March 1944, following the first large-scale USAAF attack on Berlin. From Mount Farm that distant target was beyond the Spitfire's effective radius of action, so Weitner made an intermediate stop at Bradwell Bay in Essex to top off his tanks. For this mission the aircraft carried its maximum fuel load: 84 Imp gal (374 litres) in the two main tanks in front of the cockpit, 132 Imp gal (588 litres) in the integral tanks built into the leading edge of each wing, and 90 Imp gal (400 litres) in the 'slipper' drop tank under the fuselage. Carrying 306 Imp gal (1362 litres) of fuel the Spitfire was at maximum take-off weight, and it did not handle well on the ground.

Weitner recalled: "With a full load of fuel and that narrow undercarriage, the Spit would 'lean' disconcertingly during turns when one taxied. But once you got off the ground and got a little speed she really perked up, she would

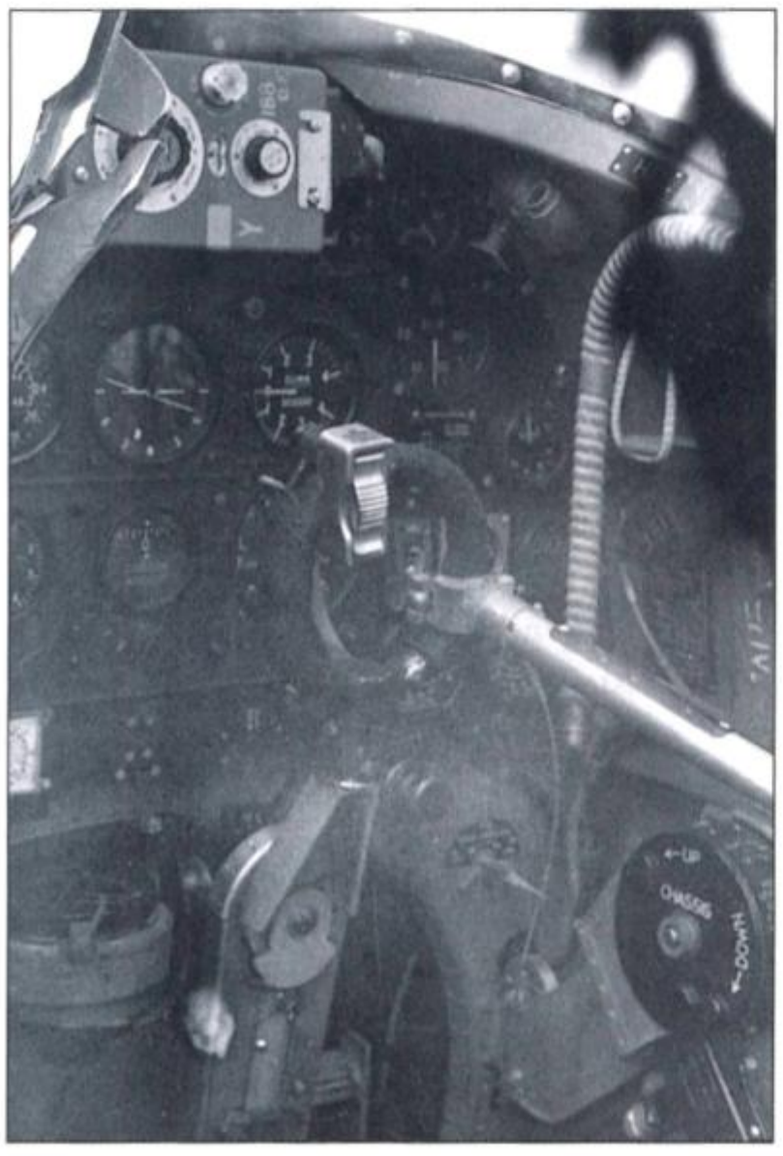
My Darling Dorothy ***was one of the Spitfire PR.Mk XIs assigned to the 14th Photo Squadron, 7th Photographic Group. The unit was based at Mount Farm, just a few miles from the RAF's main PR base at Benson.***

Right and below right: PR.Mk XIs of the 14th PS are seen during operations from Mount Farm. The Oxfordshire airfield, situated on the Thames plain, was more prone to flooding than Benson. The red band, seen on the aircraft right, was introduced in the winter of 1944/45 as a group marking.

leap away. Once the gear was up and you pulled up the nose, boy, would she climb! I took the direct route for Berlin, heading out on 086° over the North Sea towards Holland. Thirty-nine minutes after take-off I passed my first check-point, The Hague, at 39,000 ft. There was five-tenths' cloud cover below, through which I could make out the Zuider Zee. The Spitfire was easy to handle at very high altitude. This one was well trimmed and stayed pretty level. One had always to have hold of the stick, but it needed hardly any pressure. In the reconnaissance business you do not fly straight and level for long, you are continually banking to search the sky all around for enemy fighters and check the navigation.

"With all the extra clothing, the parachute, dinghy, life jacket, and oxygen mask, the narrow cockpit of a Spitfire was no place for the claustrophobic! The heavy flying clothing kept me pretty warm, though my extremities did begin to get a bit cold. The temperature outside was about -60°F, and from time to time I would stamp my feet to get the circulation going.

"Throughout the flight at high altitude my Spitfire left a long condensation trail. I could have avoided it by descending below 22,000 ft (6700 m), but I did not think that was the thing to do on a deep penetration like this. I thought the best bet was to cruise near to the ceiling of a Messerschmitt 109; then, if I had to go up, I had a little margin of altitude I could use. The Germans must have known I was up there but nobody was paying any attention to me. I thought that if enemy fighters did come after me they would have to leave trails, too, and I would get plenty of warning."



This is the cockpit of the Spitfire PR.Mk XI, with the camera control unit mounted just below the windscreen. The cockpit could get very cramped when the pilot was wearing full cold-weather flying gear for high-altitude missions.

The reason for the lack of interest in the progress of the lone Spitfire is not hard to fathom: almost every available Luftwaffe fighter in the area was in action against the force of more than 600 Flying Fortresses and Liberators and their escorts battling their way westwards to their bases in England, after the attack on Berlin. As the Spitfire neared Berlin, however, defenders finally reacted to the high-flying intruder. A glance in one of the side mirrors told Weitner he had company in the form of three enemy fighters about a mile behind and a little below.

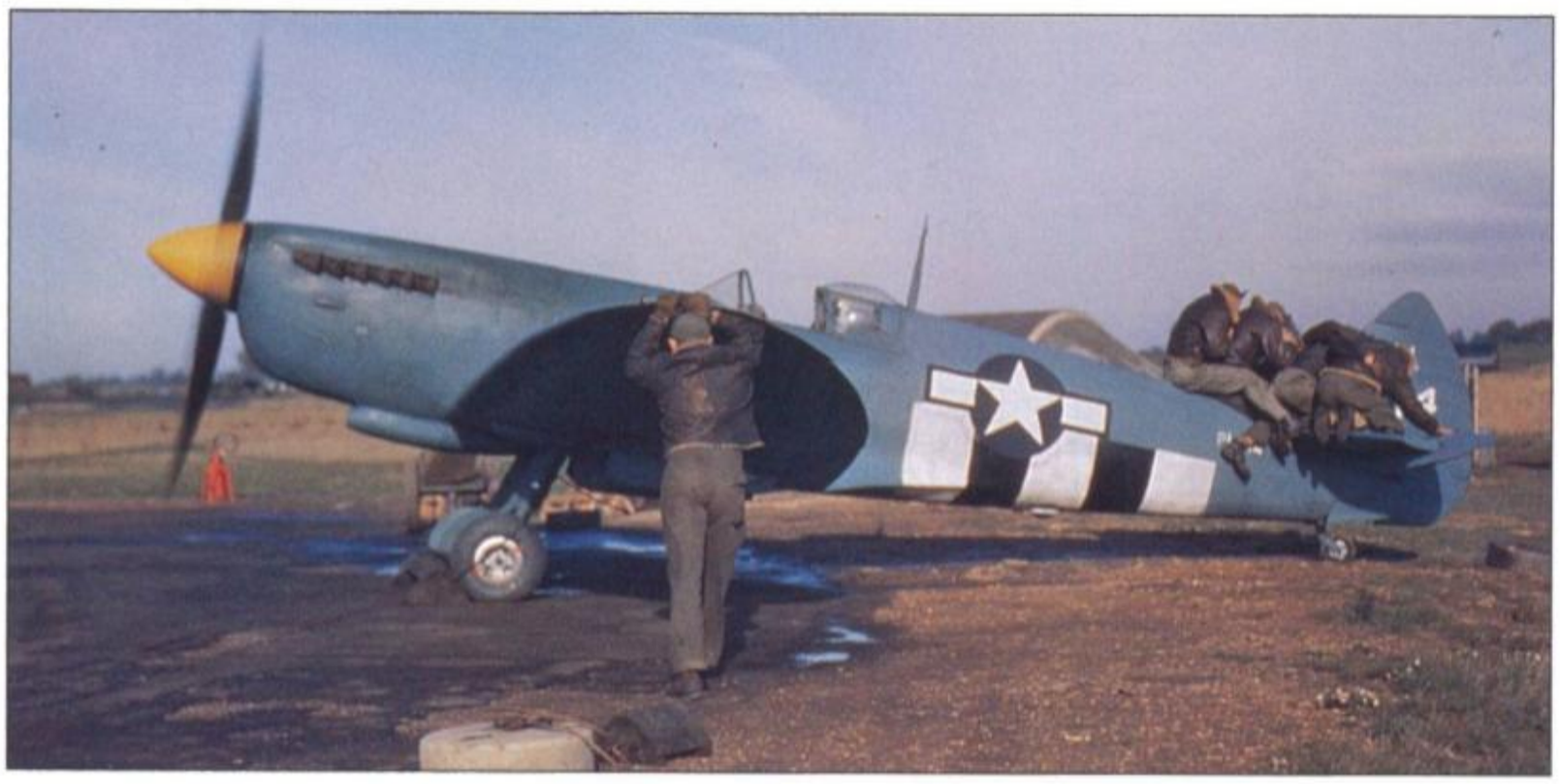
Crisis point

The discovery came at a particularly bad time for the American pilot. His engine was running on the fuel from the drop tank which, on his calculations, was almost empty. There was no gauge to measure the fuel left, however. The only indication that it was dry would be when the engine started to splutter and lose power. And that might happen at a critical time in the chase. Weitner thought of switching to one of the wing tanks and releasing the slipper tank; but this mission required every drop of fuel aboard the Spitfire. If he released the tank before it was empty, it would confuse his fuel calculations. More importantly, it might force him to abandon the mission before he reached the target. Nor could he switch the engine to one of the wing tanks for the time and return to the slipper tank later. If he did that, there was a good chance that the drop tank might not resume feeding if he reselected it. With no good alternative available, Weitner chose what he thought was the least bad: he would try to outrun the enemy fighters using the last of the fuel in the drop tank. When the fuel ran out, he would try to switch to a wing tank before the engine died.

"I pushed the throttle forward as far as it would go without selecting emergency power, eased up the nose and began to climb. The whole time I nervously held the tank selector valve, ready to switch to one of the internal wing tanks the moment the engine faltered. As I climbed through 40,000 ft I could see that the German fighters behind me had split: one went on my right and two on my left, to box me in. And at that moment the engine coughed. I immediately selected internal fuel and the engine caught right away. At 41,500 ft [12500 m] I levelled off and my indicated airspeed increased to 178 mph [286 km/h, a true airspeed of about 360 mph/580 km/h]. After what seemed forever, but was probably only two to three minutes, the German fighters began to fall back and slid out of sight. Had they come any closer I should have gone to emergency boost, but it never got that desperate."

The pursuing fighters never came close enough for Weitner to identify them, but

Major Walt Weiner was commander of the 14th Photo Squadron.* High Lady *was the PR.Mk XI he flew to Berlin on 6 March 1944.



Three photos show 14th PS Spitfires, complete with the invasion stripes added in June 1944. The 7th PG had four squadrons: the 13th, 22nd and 27th PS flying the F-4/F-5 Lightning, and the 14th with Spitfires. The latter had received Mk Vs for training in the late summer of 1943 before receiving its PR.Mk XI operational equipment. P-51Ds and Ks were received from January 1945.

almost certainly they were Bf 109Gs fitted with nitrous oxide power boosting to enhance their high-altitude performance.

Still keeping a wary eye for the fighters, Weitner checked his navigation. To the north he could make out the huge Lake Moritz, some 50 miles north-northwest of Berlin. He could not see the city itself, however, because it was hidden under a layer of industrial haze. The Spitfire lacked a pressurised cabin and Weitner had no wish to remain at maximum altitude longer than necessary, so he eased the aircraft down to 38,000 ft (11580 m). Then, suddenly, he saw the sprawling enemy capital laid out beneath him.

This is one of the photographs of Berlin taken by Major Weitner on 6 March 1944, showing fires burning in the Zehlendorf district of the city. The sensor used was the 36-in (914-mm) focal length F52 camera, the usual choice for bomb damage assessment missions.

"There was quite a lot of haze, but I could see the sun glinting off the red brick and tile houses. If the German fighters reappeared I might be able to make only one photographic run so I planned to make the first from almost due north, down wind, to get a good line of photos without drifting off the target. I rolled the Spitfire on its side to line up the string of lakes I was using as check points, levelled out using the artificial horizon and switched on the cameras."

In the rear fuselage of the Spitfire the two vertically-mounted F.52 cameras, each with a 36-in lens, clicked at five-second intervals to photograph a 3-mile (4.8-km) wide strip of ground beneath the aircraft. During a photographic run accurate flying was essential: even a small amount of bank could cause gaps in the cover. Any correction to the aircraft's flight path had to be made in the five-second intervals between photographs.

"My orders were to photograph the bombers' targets and I had been given aerial photos of the city taken previously by the RAF, with the targets marked on them. But I could see smoke rising from places other than my assigned targets so I decided to photograph the sources of the smoke also. The whole time I kept checking the sky behind my tail, as I expected further interference from the enemy fighters. But none showed up. There was some flak, I could see the smoke bursts mushrooming, but none of it was close. I spent about 25 minutes over Berlin, during which I made runs from different directions and took about 70 photographs. Then a solid layer of cloud began moving over the city from the east, and as fuel was beginning to run low I set a course of 297° for home."

On the return flight Weitner had another drama with the fuel. The order of using the Spitfire XI's fuel was, first, that in the drop tank; next the fuel in the wing leading-edge tanks, alternating between them at 15-minute intervals so the aircraft did not get out of trim; then the lower main tank and finally the upper main tank. As the last of the wing tanks emptied, the Merlin coughed briefly. Weitner switched to the lower main tank and the engine's even roar resumed. How long it would continue to do so was a moot point, however, for the American pilot was disconcerted to see the needle of the fuel gauge pushed hard against the zero mark. Could there have been a fuel leak, leaving the aircraft with insufficient fuel to regain friendly territory? Or might the gauge have frozen up?

"I discovered why I had toiled over maths for so long without learning its true value! Some

Supermarine Spitfire PR.Mk XI 14th Photo Squadron 7th Photo Group Mount Farm 1944

This aircraft, PL914, first flew in August 1944. After a brief period at Royal Air Force Benson, it was transferred to the US 8th Air Force and was assigned to the 14th Photo Squadron, 7th Photographic Group, based at Mount Farm near Oxford. The unarmed aircraft flew pre-strike and post-strike photographic missions with this unit almost until the end of the war in Europe. In April 1945 the Spitfire returned to 71 MU, RAF and went into storage. It was scrapped in April 1946.

Powerplant
Power for the PR.Mk XI initially came from the Merlin 60 series engines (first 61, then 63). From PL768 onwards (after one installation in PL763) the Mk XI was fitted with the Merlin 70. This developed 1,475 hp (1100 kW) at high altitude, and drove a Rotol R12/4F5/4 four-bladed propeller. The enlarged oil tank under the nose, which caused the pronounced bulge to the cowling lines, held 14.4 Imp gal (65.5 litres).

Fuel
The two main fuel tanks, with a total capacity of 85 Imp gal, were mounted behind the engine. In addition, this variant carried 132 Imp gal (588 litres) in integral tanks built into the leading edge of each wing. Also, for the longer range missions, it could carry a 90-Imp gal (400-litre) 'slipper' drop tank under the fuselage.

Wing cameras
Later production PR.Mk XIs had provision to carry a vertical F24 5-in (12.7-cm) focal length camera in a blister mid-way along each wing.

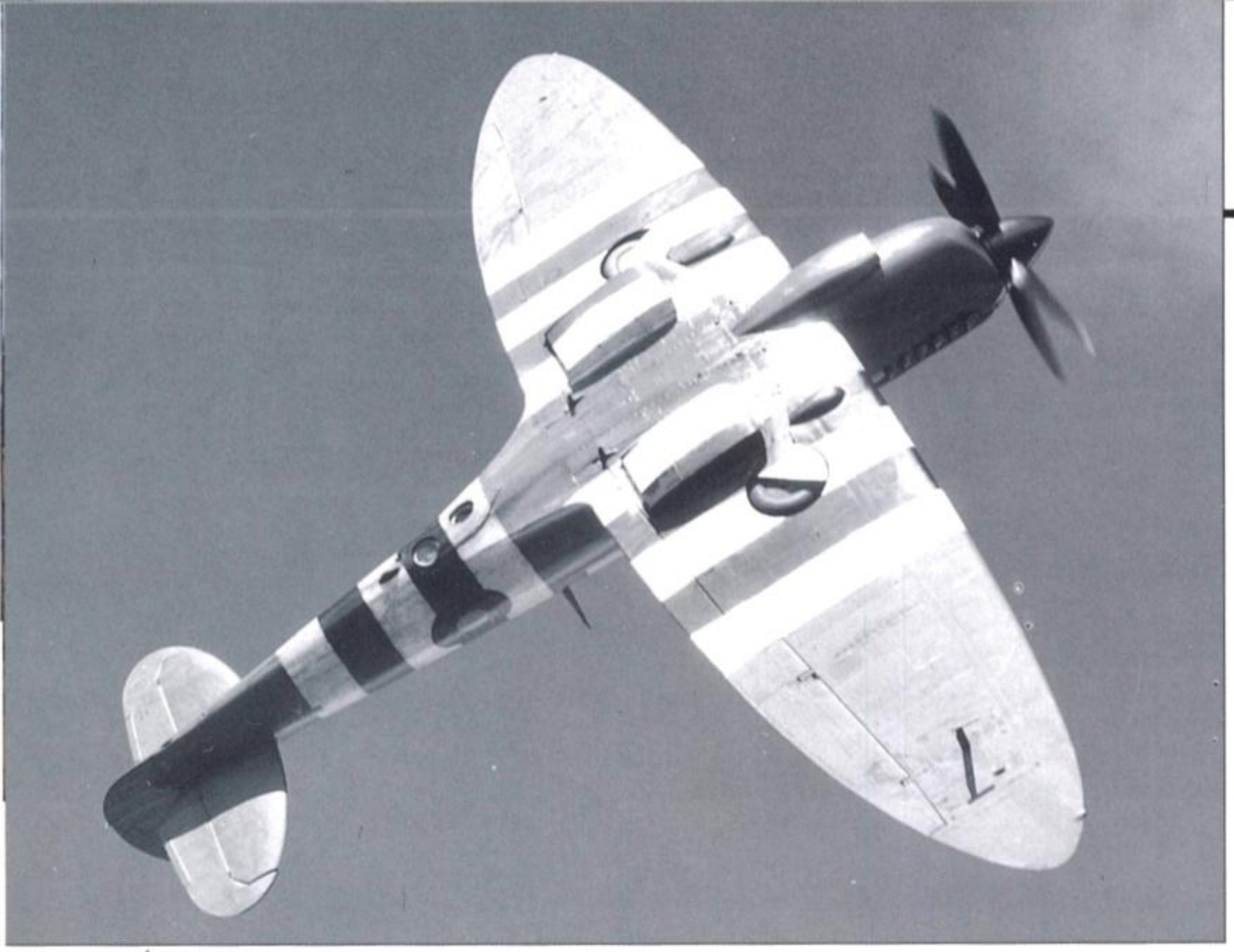
Colour scheme and markings
The Spitfire wore the medium blue colour scheme that was standard for RAF high-altitude reconnaissance planes throughout most of World War II, known as 'PRU Blue'. The RAF serial number was painted in white on the rear fuselage and repeated in larger characters on the fin and rudder. The Spitfire carried invasion stripes under the fuselage. Later the 7th PG adopted red stripes on the forward fuselage as a group marking.

Camera heating
On the PR.Mk XI the cameras were heated by hot air, ducts running from the cabin heating system (itself fed directly from the radiator) back to a box covering the magazines and shutters of the cameras.

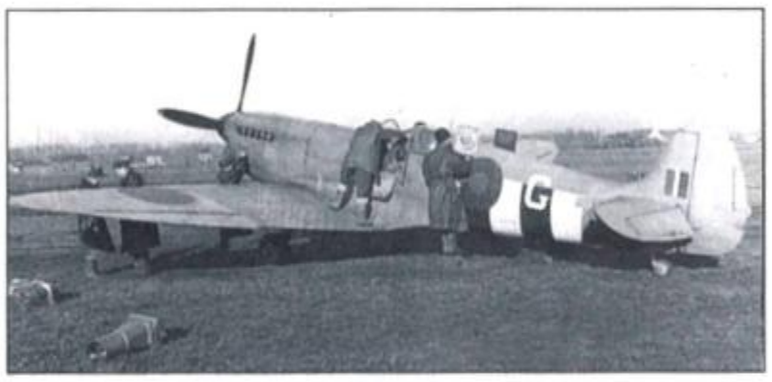
Main camera installation
The 'U', or Universal, camera installation was located in the rear fuselage. On aircraft operated by this unit it usually comprised two 36-in (91.44-cm) focal length cameras in a 'split pair' installation, the forward camera pointed just starboard of the vertical and the rear camera pointed slightly to port. These were located between frames 13 and 15 of the fuselage structure. If shorter focal length vertical cameras were carried in the rear fuselage, aircraft could carry an oblique camera facing either to port or to starboard.

Performance
The PR.Mk XI had a top speed of 417 mph (671 km/h) at 24,200 ft (7376 m) and a ceiling of 44,000 ft (13411 m). Endurance was 5.4 hours, and range was 2,300 miles (3700 km).

Undercarriage
All three wheels and tyres were made by Dunlop, the mainwheels being AH2061 units and the tailwheel an AH2184/IX. The first 45 PR.Mk XIs had fixed tailwheels, retractable wheels being fitted from MB794 onwards.



Wearing full invasion stripes, a PR.Mk XI of No. 541 Sqn from Benson cavorts for the camera. Noteworthy are the two camera windows in the underside of the fuselage. PR.Mk XIs had the 'U' (Universal) camera installation allowing a variety of sensors to be fitted.



Ground crew service the camera systems of a PR.Mk XI of No. 16 Sqn. The oblique camera window hatch is open, and an F52 camera lies on the grass.

rapid calculations almost proved the main tanks had to be full. During these reveries nothing of a threatening nature showed itself except a few far-off trails to the east. Soon the cloud covering the English coast was within gliding distance, and all was well again. Over the North Sea I descended to 30,000 ft and called 'Gangplank' [Bradwell Bay] on the VHF for a homing. Over the coast of East Anglia the gas gauge suddenly came to life showing about 20 Imp gal [89 litres]. At my altitude I knew I had enough fuel to reach Mount Farm without having to land at the coast to take on more."

Weitner descended to Mount Farm with the engine throttled back, made a low pass over the airfield, pulled round hard into finals, lowered his flaps and undercarriage and landed. He had been airborne for four hours and 18 minutes. "On entering the dispersal area the gas and the maths ran out simultaneously, leaving a spluttering and dead engine on my hands just a few feet short of 'according to plan'."

The unpopular Mk X

The system of allocating Spitfire numbers was anything but methodical, and the PR.Mk X entered service more than a year later than the PR.Mk XI. The two variants were similar except that the Mk X was fitted with a pressurised cabin. Only sixteen examples were built and these entered service with Nos 541 and 542 Squadrons in May 1944. The commander of the latter unit, Squadron Leader Alfred Ball, remembered the PR.Mk X without any great affection.

"I flew the PR.Mk X a few times on operations. They were not popular because of the poor visibility out of the very thick perspex canopy. Outside everything looked a slightly discoloured yellow, the perspex was not as clear as on an ordinary Spitfire. Also, with the extra weight of the pressure cabin, the Mk X felt much heavier than the Mk XI. We preferred the unpressurised Mk XI to the Mk X."

The near-immunity of these versions from fighter interception lasted until the spring of 1944. Then the Luftwaffe deployed its first jet fighter types, the rocket-propelled Messerschmitt Me 163 and the turbojet-powered Me 262. High-flying Allied reconnaissance aircraft, unarmed and alone, offered perfect targets on which the German pilots converting to the jets could make practice interceptions.

PR.Mk 19 – The Master Spy

To overcome the threat of interception from German jet fighters, Supermarine designed a long-range unarmed reconnaissance variant of the Spitfire powered by the Rolls-Royce Griffon engine. This, the PR.Mk 19, had integral wing tanks as fitted to the PR.Mk IV and the PR.Mk XI. (Note, in 1943 the RAF changed from Roman to Arabic mark numbers for its aircraft.)

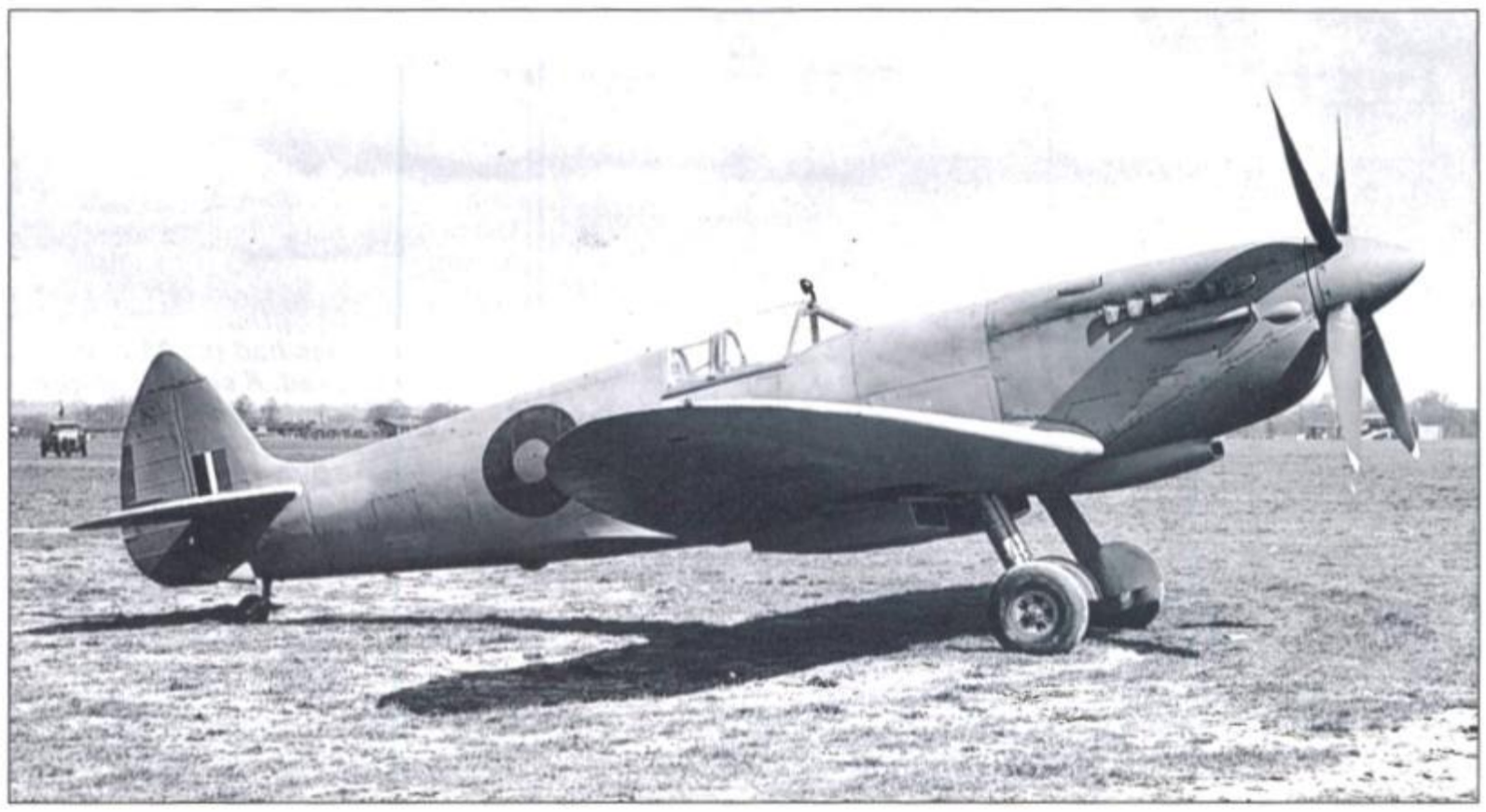
The new variant entered service in May 1944 and provided a huge advance in performance over the PR.Mk XI. Later production PR.Mk 19s were fitted with a pressurised cabin of improved design which overcame the shortcomings of that fitted to the PR.Mk X. With the power from the Griffon engine, the extra weight of the pressurised cabin caused no noticeable deterioration in performance. Comfortably ensconced in their pressurised cabins, pilots often took this variant above 45,000 ft (13716 m).

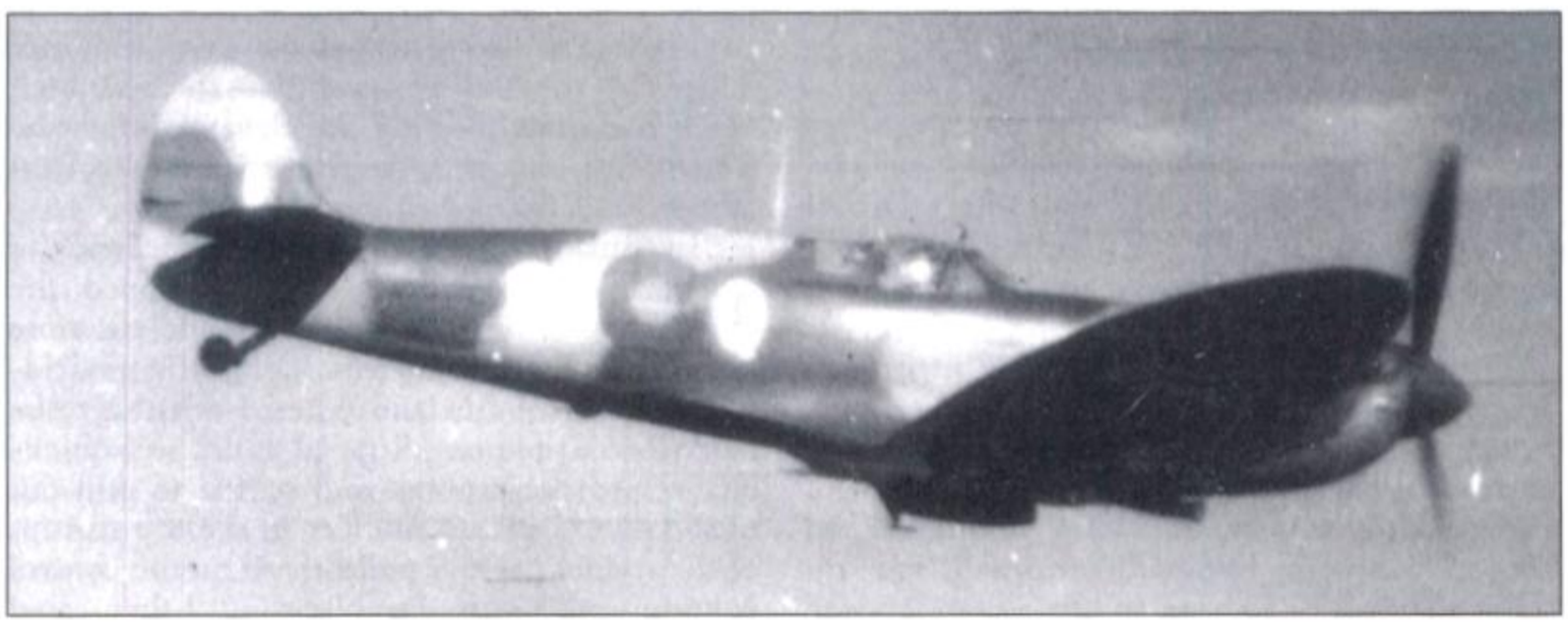
If the Spitfire PR.Mk 19 pilot saw an intercepting jet fighter in time, he had little difficulty in outmanoeuvring it. Alfred Ball recalled: "I encountered Messerschmitt 262s on a couple of occasions. Unless your eyes were shut when they jumped you, you could usually get away from them. They had a long climb to reach us, and they could not stay with us for very long. I would wait until the 262 pilot was about to open fire, then pull into a tight turn. You had to judge the turn correctly – if you turned too soon it was not difficult for him to pull enough

With a Hurricane and Mosquitoes in the background, this PR.Mk XI of No. 681 Squadron was photographed at Monywa, Burma in 1944. The aircraft sports the light blue/dark blue national insignia worn in the theatre to avoid any confusion with Japanese aircraft.

Right: The PR.Mk X was very similar to the PR.Mk XI. The major external difference was the intake scoop on the starboard side of the cowling, this providing air for the blower feeding the pressurised cabin. Due to problems with the pressurisation, the Mk X entered service more than a year after the Mk XI, and was never popular with its pilots.

Below: This PR.Mk XI was captured intact and flown by the Luftwaffe. It wears over-sized national insignia to prevent engagement by 'friendly' fighters or flak.





What it lacks in clarity this photo makes up for in rarity: it depicts a PR.Mk XIII in the markings of No. 718 Sqn, Fleet Air Arm. Only 26 of this variant were produced, and after their front-line service with the RAF was over, they were transferred to the Navy unit at Henstridge, for use in the army co-operation training role.

deflection and you were a sitting duck. Provided you handled your aircraft properly, it was very difficult for them to shoot you down."

Altogether, 225 examples of the PR.Mk 19 were built, before production of this version ended in the spring of 1946.

New low-level reconnaissance variants

As stated earlier, the Spitfire PR.Mk VII (aka PR.Mk IG) armed reconnaissance unit served successfully during the early war years in the low-altitude 'dicing' role. Early in 1943 these were replaced by the PR.Mk XIII, with a low-altitude rated Merlin 32 developing 1,645 hp (1227 kW) at 2,500 ft (792 m). The new variant had a maximum speed of 349 mph (562 km/h) at 5,400 ft (1650 m). The camera installation and fuel tankage was the same as the earlier variant. The defensive armament was reduced to four 0.303-in machine-guns in the outer wing positions. Only 26 PR.Mk XIIIs were built, all converted from PR.Mk VIIs or Mk I or Mk V fighters. The type saw service with Nos 4, 400, 541 and 542 Squadrons. Later, after replacement in front-line units, some Mk XIIIs served with No. 718 Squadron, a Fleet Air Arm army co-operation training unit. In November 1944 a fighter-reconnaissance version of the Griffon-powered Spitfire XIV entered service, fitted with an oblique camera in the rear fuselage and designated the FR.Mk XIV. This variant retained the fighter's armament of two 20-mm cannon and four machine-guns, and was a considerable improvement over the PR.Mk XIII that it replaced.

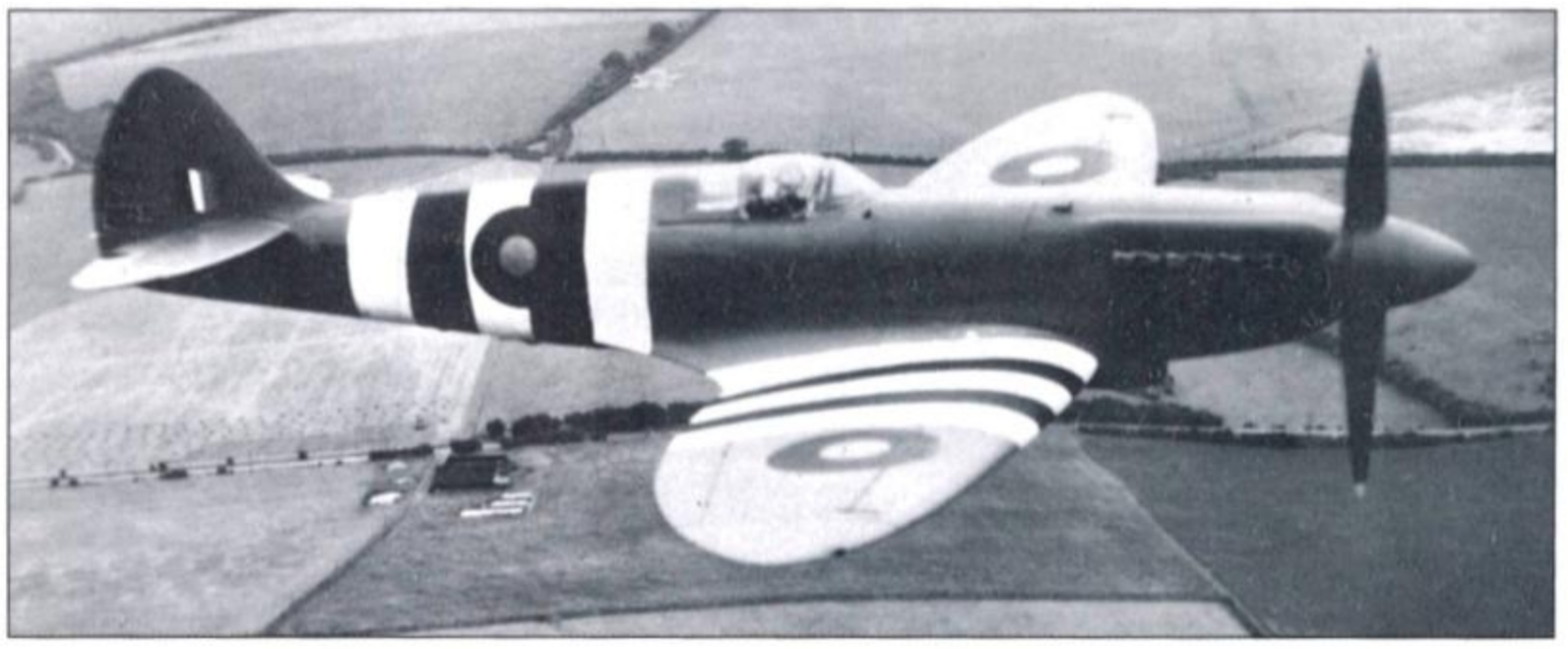
Fastest dive by a piston-engined aircraft – ever

After the war Spitfire PR.Mk 19s made some truly remarkable high-altitude flights. In the RAF the term 'service ceiling' was defined as the altitude where the aircraft's rate of climb fell below 100 ft (30 m) per minute. In the case of the PR.Mk 19 the service ceiling was officially recorded as 42,600 ft (12990 m). Yet that figure gave no indication of the altitude an aircraft could reach in a long cruise climb to a distant target. During the post-war air defence exercises in the United Kingdom, Spitfire PR.Mk 19s sometimes overflew their targets at 49,000 ft (14940 m).

Even that magnificent performance was eclipsed early in 1952 by a PR.Mk 19 of No. 81 Squadron based in Hong Kong. On 5 February Flight Lieutenant Ted Powles took off from Kai Tak for a meteorological height climb to 50,000 ft (15240 m). His briefing was to record the outside air temperature at various altitudes and report on any clear air turbulence and high wind speeds he encountered. The purpose of the sortie was to collect data on high-altitude meteorological conditions, to assist with a proposed air service through the area by the new Comet jet airliner.

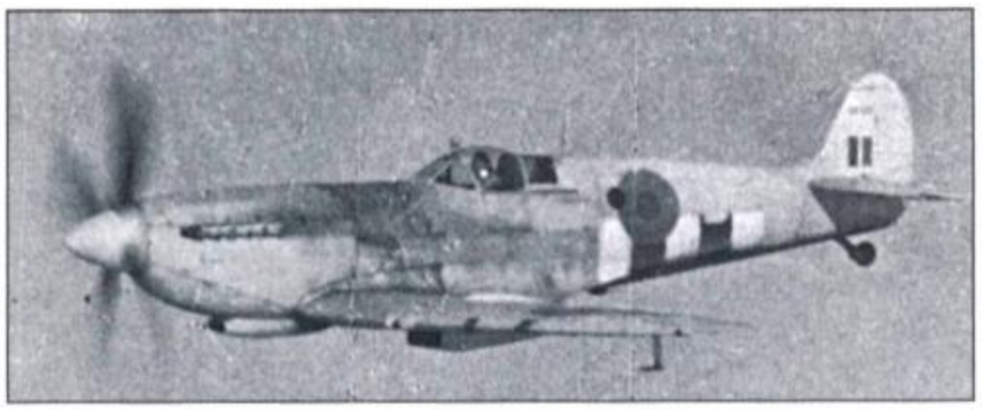
At this point a few words of explanation are necessary concerning the effect of the height of the stratosphere on Powles' sortie. Over Great Britain the height of the stratosphere is around 36,000 ft (10973 m) and above that the air temperature remains steady at about -54°C (-65°F). Approaching the Equator, the height of the stratosphere gradually increases. In tropical latitudes (Hong Kong lies just south of the Tropic of Cancer), the stratosphere begins at about 50,000 ft (15240 m). Above that altitude the air temperature is steady at about -72°C (-97°F).

The lower the temperature of the air entering the carburettor air intake of the Spitfire, the



This was an early production example of the Spitfire PR.Mk 19, the ultimate PR version. It served with No. 541 Sqn, which received its first aircraft in June 1944. Early PR.Mk 19s lacked cabin pressurisation.

Fighter Reconnaissance Spitfires



No. 16 Squadron operated this Spitfire FR.Mk IX in the tactical reconnaissance role over Normandy following the June 1944 invasion. The aircraft had full armament options, although this aircraft has had the 20-mm cannon removed. A single oblique camera was mounted in the port side of the fuselage, and the aircraft wore pale pink scheme for below-cloud photography.

The Spitfire FR.Mk XIV took over much of the low-level tactical reconaissance role from dedicated PR Spitfires. These are with No. 11 Squadron, seen in 1947 at Miho, Japan.

The similar FR.Mk 18 was the final fighter-recce version, with strengthened wing. This example served with No. 28 Sqn, based at Seletar in Singapore.

greater its density and therefore the greater the power developed by the engine. Thus, due to the increased height of the stratosphere, in the tropics the Griffon engine developed more power at altitude than it would have over Europe.

Powles flew his sortie methodically, levelling at each 5,000 ft (1524 m) step to collect and record the required readings. Then he resumed his climb to the next step. As he neared the final part of the ascent, about 1.5 hours after take-off, the Spitfire's rate of climb fell to a few tens of feet per minute. Finally he reached 48,500 ft (14785 m) indicated on his altimeter, which represented a true altitude of 50,000 ft (15240 m).

Perfect conditions

There, Powles found the Spitfire's controls extremely sensitive although the aircraft still had some performance in hand. He recalled: "I had been up to 48,500 ft indicated, that was 50,000 ft true, at least half a dozen times during earlier sorties. But on that particular day the conditions were perfect, the aeroplane was flying beautifully, I had the time and I had the fuel, so I decided to see if I could get her to 50,000 ft indicated."

Carefully he nudged the aircraft higher until eventually the altimeter read 50,000 ft – a true altitude of 51,550 (15715 m). The airspeed indicator read 108 kt (124 mph, 200 km/h, equating to a true airspeed of 275 mph, 443 km/h).

"I was flying on the very edge of the Spitfire's performance envelope and I felt exhilarated. It felt as if I was trying to balance on top of a ball. I had to fly on instruments, because if I looked over the side a wing would start to drop. I was flying almost on the stall, and if a wing did drop I had to pick it up using opposite rudder; if the starboard wing dropped I eased on left rudder, so that wing moved through the air a little faster and slowly rose."

He could not use the ailerons to hold the wings level, because lowering the surface would stall the wing on that side and cause the Spitfire to flip on its back.

Suddenly the red cabin pressurisation warning light illuminated, indicating that cabin pressure had fallen below a safe level. Now Powles had to make a rapid descent below 43,000 ft (13106 m), or the reduction in pressure would cause the nitrogen in his blood to expand and bring on the painful condition known as 'the bends'. He pushed the control column forward, throttled back and moved the pitch lever to 2,200 rpm to prevent the propeller from overspeeding the engine.

"While I was checking to see if the pressurisation seal around the canopy had burst, the aircraft started to shake and when I again looked at my flying instruments, I was shocked to see the needle on the airspeed indicator just passing the 280 kt [322 mph; 519 km/h] mark (the Pilot's Notes state that 260 kt should not be exceeded above 40,000 ft!).

"I immediately pulled back on the control column, but the more I pulled the steeper the aircraft dived. It was now shaking so violently that I could not read the instruments. The Spitfire was in a vertical dive and I was standing on the rudder bars. The control column was immovable and I was afraid if I pulled any harder something would break. Beside the vibration, the aircraft started to yaw from side to side. I felt as though a giant hand was shaking it."

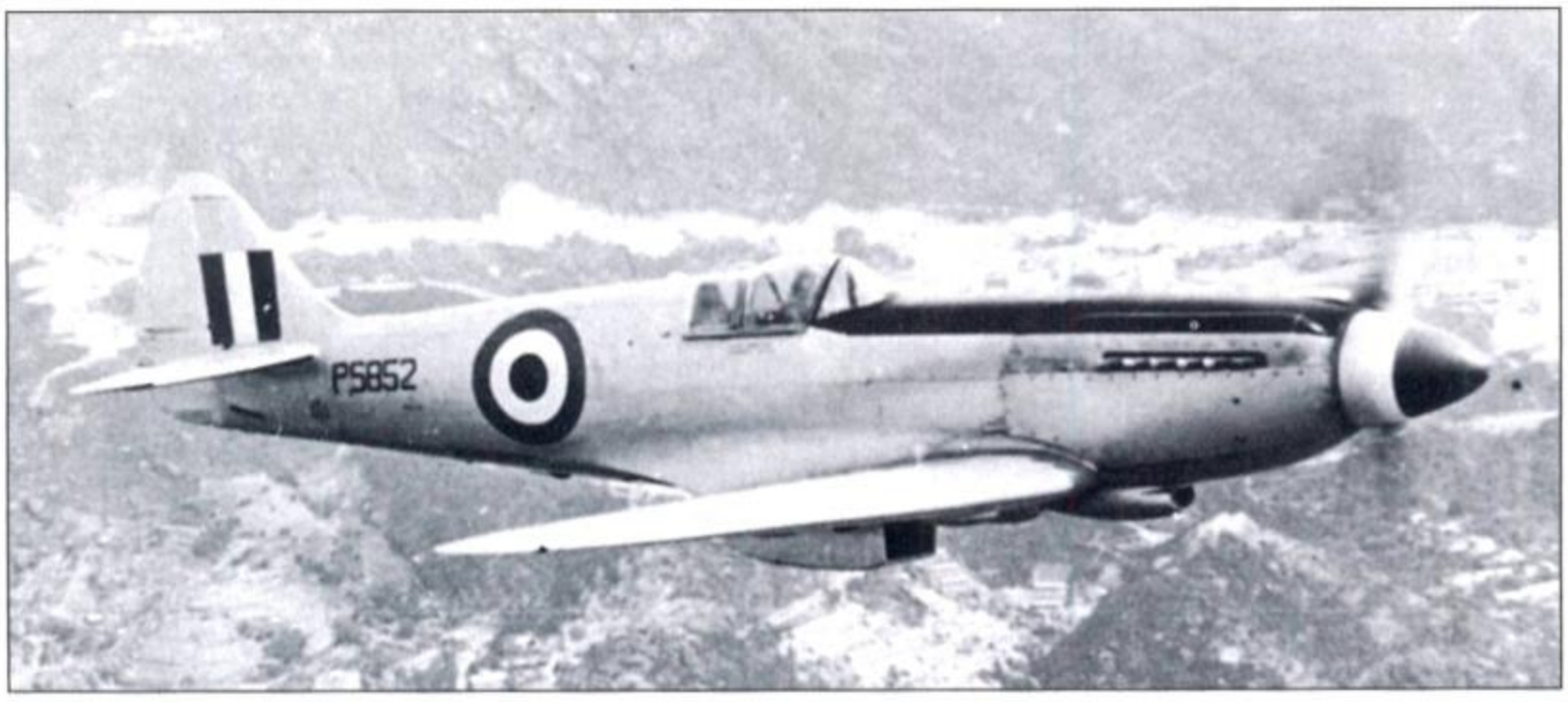
High-Mach mist

The pilot's first thought was to try to ease up the nose using the elevator trim tabs. Glancing out over the wings he noticed that they were covered in a strange mist (caused, we now know, by the shock waves that form at high Mach numbers). Fearing the elevators might be torn off by the airflow if he moved the trim tabs, Powles decided to leave them alone.

"Eventually, after the longest few seconds of my life, the vibration and yawing stopped, the mist was clearing from the wings and the nose started to lift. I was still pushing on the unyielding control column and when I felt the resistance lessen the nose dropped again, so I quickly reversed the pressure and started to pull out of the dive. I placed my feet in the top stirrups of the rudder bar and pulled hard on the control column until I started to black out. I then eased the pressure. I could not afford to lose control at this point."

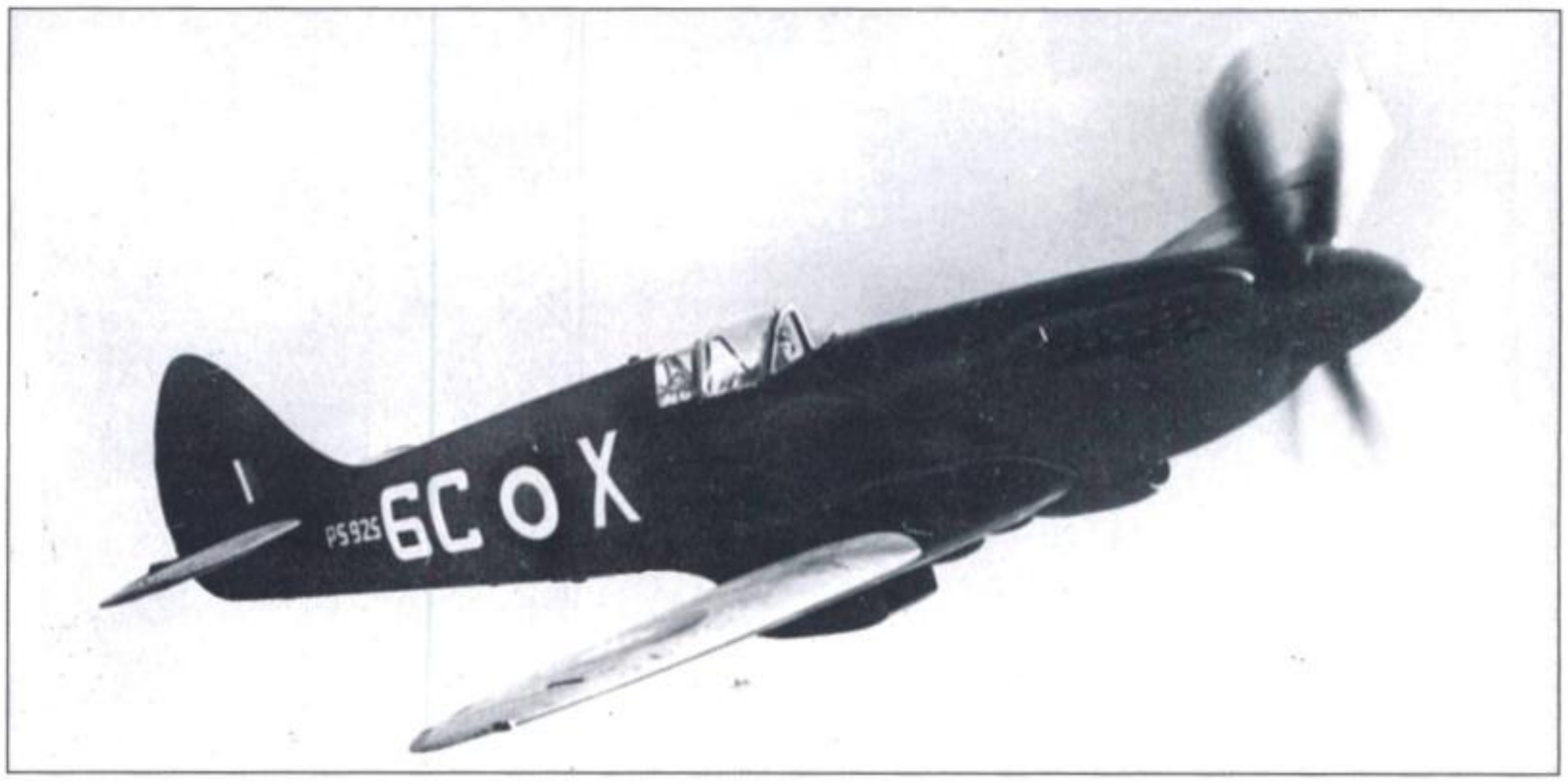
When Powles next scanned his instruments he saw the airspeed indicator unwinding rapidly through 500 kt (575 mph; 926 km/h), and the altimeter steady at 3,300 ft (1006 m). As the

Shown above is Flight Lieutenant E. C. 'Ted' Powles of No. 81 Squadron, whose account of a hair-raising high-speed dive is given above. PS852 (left) was the aircraft involved in the 5 February 1952 incident.



This PR.Mk 19 was photographed during high-altitude trials of the 180-Imp gal (818-litre) ferry tank which was fitted to the belly between the main undercarriage legs and radiators. On operational missions PR Spitfire pilots would try almost anything to avoid leaving a vapour trail.

Right: Seen post-war, this PR.Mk 19 wears the '6C' codes of the Photographic Reconnaissance Development Unit.



super-cooled aircraft entered the moist warm air low down, condensation froze on the inside of the canopy, preventing the pilot seeing outside. He then tried to open the canopy, but it was frozen shut and resisted his efforts to budge it.

Powles collected his thoughts and realised he was still not safe. Unable to see outside the aircraft, he had little idea of his position. And there were mountain peaks in the area extending above 5,000 ft (1524 m). He initiated a climb on instruments, heading southeast towards the sea.

"When I pulled out of the dive and levelled out, the altimeter indicated 3,300 ft. I started a climb with about 1,750 ft per min [8.89 m/sec] showing on the vertical speed indicator, but the altimeter stayed at 3,300 ft for quite some time before it started to rise."

Lagging altimeter

It was chillingly obvious that during the dive the altimeter had 'lagged' considerably in the reading it gave. When the Spitfire bottomed out of the dive must have been a good deal lower than the 3,300 ft shown on the instrument. Ted Powles had been very lucky indeed to pull out of the dive before the aircraft plunged into the ground or the sea.

Then matters began to sort themselves out. A call to Hong Kong Approach Control produced a radio bearing which showed that the Spitfire was safely over the sea. Then the canopy unfroze, allowing the pilot to slide it back. The inrush of warm air quickly cleared the frosting off the perspex and normality returned.

After he landed, Powles asked that Spitfire be given a thorough examination to see if the airframe had been overstressed. Surprisingly, the aircraft emerged from its torturous experience without any discernible harm.

Safely on the ground, Powles now tried to establish just what had happened during the dive. He had noted the times when he initiated the rapid descent, when he passed through 44,000 ft just before the vibration started, and again after the pull-out. He had taken nine seconds to descend from 50,000 ft (15244 m) to 44,000 ft (14432 m) indicated, and 47 seconds to descend from 44,000 ft until he levelled out at 3,300 ft indicated (which, due to altimeter lag, was probably well below 2,000 ft/610 m). The descent through about 42,000 ft (12800 m) and the subsequent pull-out had taken 47 seconds, which meant that at some time in the dive the Spitfire must have exceeded 1,000 ft per second, or over 680 mph (1095 km/h). The aircraft had no Mach meter, but Powles had recorded the outside air temperatures at 5,000 ft (1524 m) intervals during the climb so it was a simple matter to work out the speed of sound for each altitude. After applying corrections for compressibility and other factors he calculated that the Spitfire had reached a speed of at least Mach 0.94 when it passed 15,000 ft (4573 m) in the dive, equivalent to 690 mph (1111 km/h).

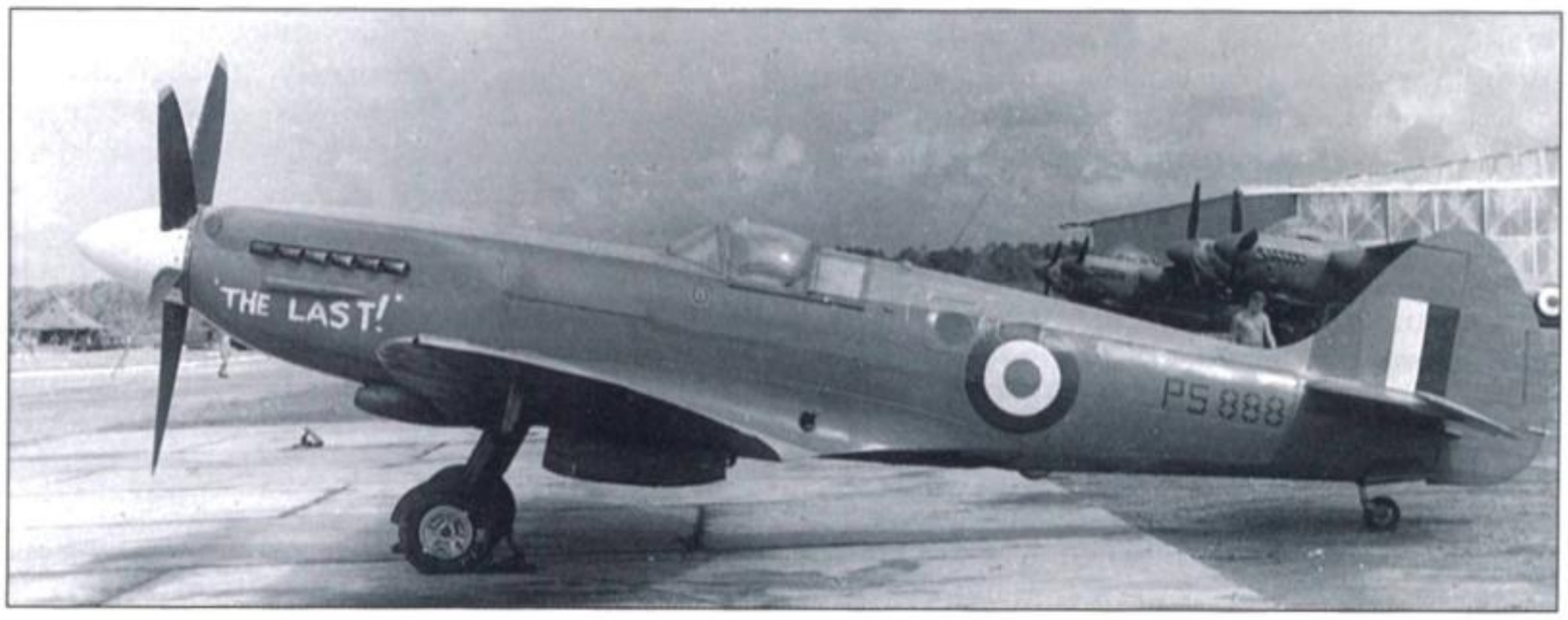
Powles had considered using the elevator trim to raise the nose of the aircraft during the dive, but it is as well he did not try it. Later Jeffrey Quill, one-time chief test pilot at Supermarine, looked over the figures and expressed the view that use of the trim tabs in those circumstances might have caused a high-speed stall after which the aircraft would probably have disintegrated. As it was, when the aircraft reached the denser air below 15,000 ft its speed started to decay. Thereafter, the Spitfire exerted its natural tendency to pull itself out of the dive.

In the absence of any serious counter-claim, it appears likely that on 5 February 1952 Ted Powles achieved the highest altitude ever attained by a Spitfire, 51,550 ft (true). And during that subsequent hair-raising dive he reached the highest Mach number, Mach 0.94, and the greatest speed, 690 mph, ever attained by a Spitfire – or any other piston-engined aircraft for that matter. In each case, those figures provide resounding endorsements of both the soundness of Reginald Mitchell's original design and of the structural improvements made to the aircraft during its lengthy development life.

Dr Alfred Price

Above: PR.Mk 19s remained on secondary duties with the RAF for some time after retirement from the front line. PS915 was one of the last three Spitfires in regular RAF use, flown by the Meteorological Flight at Woodvale until 1957.

Below: PS888 occupies a special place in RAF history, for it flew the last operational sortie by a Spitfire. Suitably adorned, the aircraft was launched out of Seletar by No. 81 Sqn on 1 April 1954 on a mission to photograph areas thought to harbour Communist guerrillas during the Malayan campaign. The unit also flew the last operational RAF Mosquito mission.



German Jet VTOL

Following ambitious but ultimately doomed efforts to develop a vertical take-off interceptor in the closing days of World War II, Germany returned to the VTOL concept in the 1960s, when it developed three extraordinary aircraft able to take advantage of new engine technology for lift as well as propulsion. The VTOL race took place in a number of countries, but only Germany was able to fly examples of a supersonic fighter, medium airlifter and a low-level ground attacker all dependent on jet lift. In the end, however, the projects were cancelled one by one. Since then, the only VTOL aircraft in Germany have been RAF Harriers.

Germany, at the heart of Europe, has also tended to be at the heart of wars. In the modern world, warfare means destruction from the air by manned aircraft and missiles. It stands to reason that the only kind of aircraft that can survive are those that can disperse away from known air bases, and the only fast jets that can do this are VTOLs (Vertical Take-Off and Landing). Yet, having played with many kinds of VTOL aircraft for over 50 years, today's Luftwaffe has none in service, and no plans to operate any.

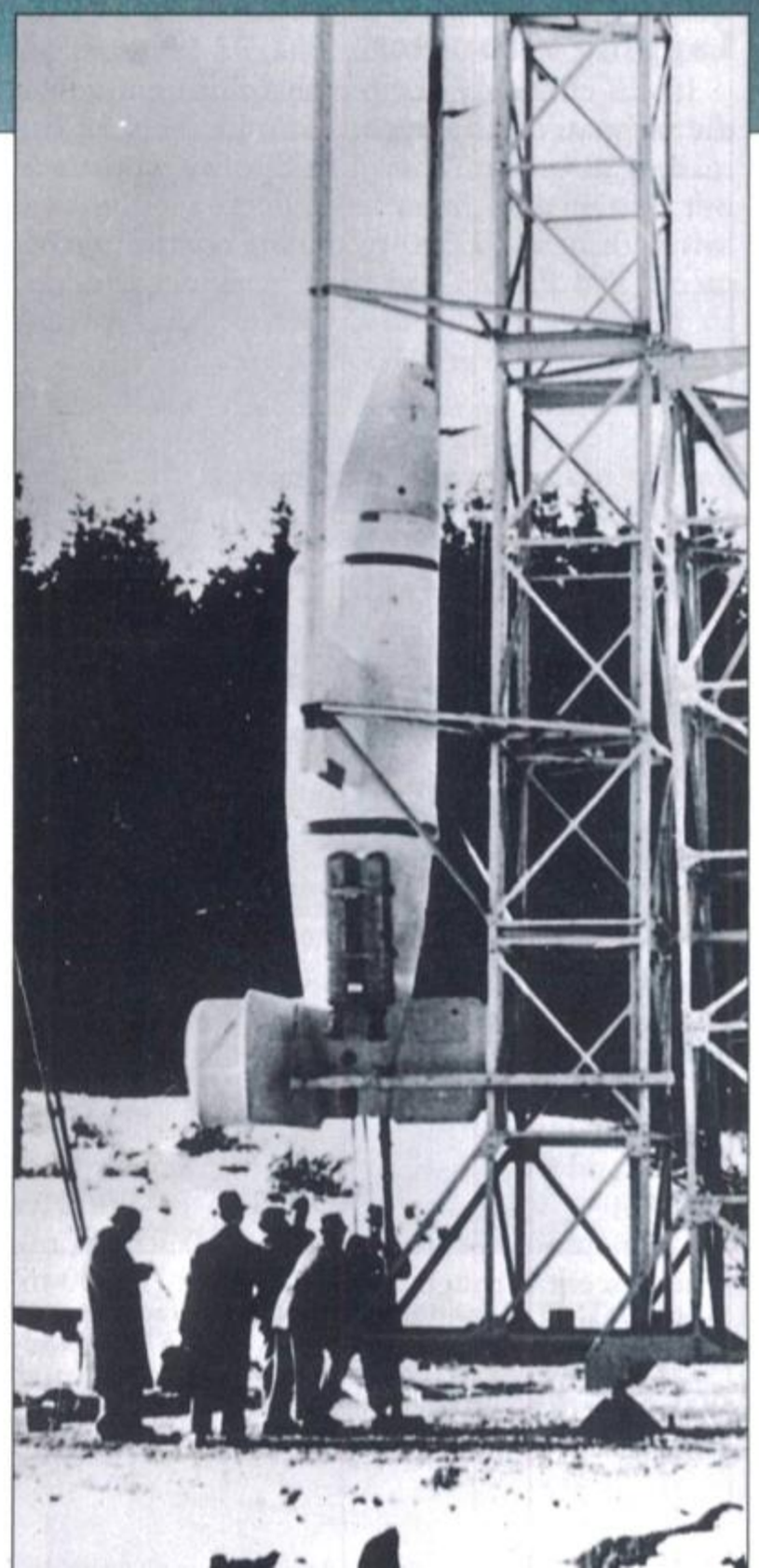
Germany's first VTOL, the Bachem Ba 349, was also the first jet VTOL in the world, and certainly the first to reach operational service. Utterly unlike any aircraft built before, it was the result of the most pressing operational necessity. The Ba 349 had its roots in a proposal made in July 1939 by rocket pioneer Dr Wernher von Braun. He suggested the development of a fighter for the defence of important targets, powered by a large rocket engine and fired vertically, like the A.4 (later called 'V-2') rocket missile on which he was working. The obviously very short radius of action and flight duration were considered outweighed by the unprecedented rate and angle of climb, high speed and survivability against fire from bomber formations. The concept was rejected as being too radical, but it seemed a good idea to Erich Bachem, technical director of the Fieseler aircraft firm (which was later to design the other 'V-weapon', the Fi 103 or 'V-1').

Above: Although initially conceived as a combat aircraft prototype, the VJ 101C emerged as a pure research machine scaled down to fit the available engines. With little superfluous weight or drag, the VJ 101C X2 became one of the few truly supersonic VTOL aircraft, although pivoting afterburning engines proved to be a dead end and only two prototypes were built.

Right: The Bachem Ba 349 Natter was probably the most extraordinary of the German projects to reach the hardware stage at the end of the war. Manned test flights were preceded by launches of unmanned versions, the first with all rockets firing on 23 February 1945.

Although the RLM (air ministry) showed no interest, Bachem kept refining paper studies for a vertically launched rocket fighter. It was inevitable that such an aircraft would have extremely short endurance under power. Thus, it would be used only to climb at unprecedented speed to intercept bombers flying overhead and would then at once return, gliding back with its rocket propellants exhausted. It would make the concept even more radical, but Bachem decided it would be sensible to design the aircraft to be semi-expendable. Apart from the pilot, only the expensive rocket engine was to be recovered by parachute. The rest was to be as simple as possible.

In May 1944 the RLM issued an urgent requirement for a short-range jet or rocket interceptor to try to defend major targets against the increasingly devastating daylight attacks of



The VFW/Fokker VAK 191B first flew in 1970, 10 years after design began. In that time, the design was surpassed by the superficially similar HS Harrier. The NATO requirement for a VTOL strike aircraft was first changed, then dropped.

the Allied heavy bombers, especially the USAAF. Bachem's project was again rejected, because its semi-expendable nature was contrary to the requirement. Undeterred, Bachem enlisted the support of Himmler, the most feared man in Germany, and he instantly got the project adopted as a priority programme. The 8-series designation was Ba 349, with the popular name Natter (Viper).

Despite the estimated speed of 621 mph (1000 km/h), the airframe was made of wood. As there was no need for a normal take-off or landing, the wings were tiny and there was no landing gear. The Ba 349 was blasted off a vertical ramp under the 4,410 lb (19.61 kN) thrust of four solid boost motors, thereafter continuing to climb almost vertically on the 3,748 lb (16.67 kN) thrust of a Walter 509A-1 rocket engine, the same as that fitted to the Me 163B. This was fed with T-Stoff (concentrated hydrogen peroxide) and C-Stoff (methanol and hydrazine hydrate) in steel tanks amidships.

The pilot sat immediately in front of the tanks under a hinged canopy in a fully armoured cockpit. It was considered that, as he did not have to worry about the take-off or landing, he needed little training. All he had to do was use the simple manual controls to aim the aircraft at the target, such as a formation of B-17s, and, at a suitable fairly close range, jettison the plastic nose cap and fire the 24 Hs 217 Föhn (storm) rockets which filled the nose. A single hit by these 73-mm projectiles would cripple a heavy bomber. The pilot then would turn away, undo his seat harness and fire the recovery system. This would disconnect the control column, jettison the nose complete with windscreen and stream the big braking parachute in the tail. The sudden deceleration would shoot the pilot out of the open nose, while the parachute would recover the rocket engine for re-use, the mid-fuselage and wings simply falling to the ground.

Just too late

Design began in August 1944. Three months later gliding trials, in which the aircraft was towed to altitude by an He 111, showed excellent handling at speeds from 425 mph (685 km/h) down to the minimum of 124 mph (200 km/h). Vertical firings of unpiloted prototypes followed, until the first piloted launch took place on 28 February 1945. At a height estimated at 1,640 ft (500 m) the canopy came off, and the Natter arched over and dived into the ground. It was thought the canopy had hit the pilot, Lothar Siebert, knocking him out.

Although three successful manned shots followed, by March 1945 this radical aircraft was no longer seen as a practical weapon. Instead of thousands, just 36 production examples were completed. In April 1945 one group of 10 was set up near Stuttgart to wait for the bombers, but Allied tanks arrived first.

In May 1955 Allied control of West Germany was replaced by national sovereignty as the Bundesrepublik, and the Federal Defence Ministry and Luftwaffe were reborn. The renascent German aircraft industry at once began planning German military aircraft.

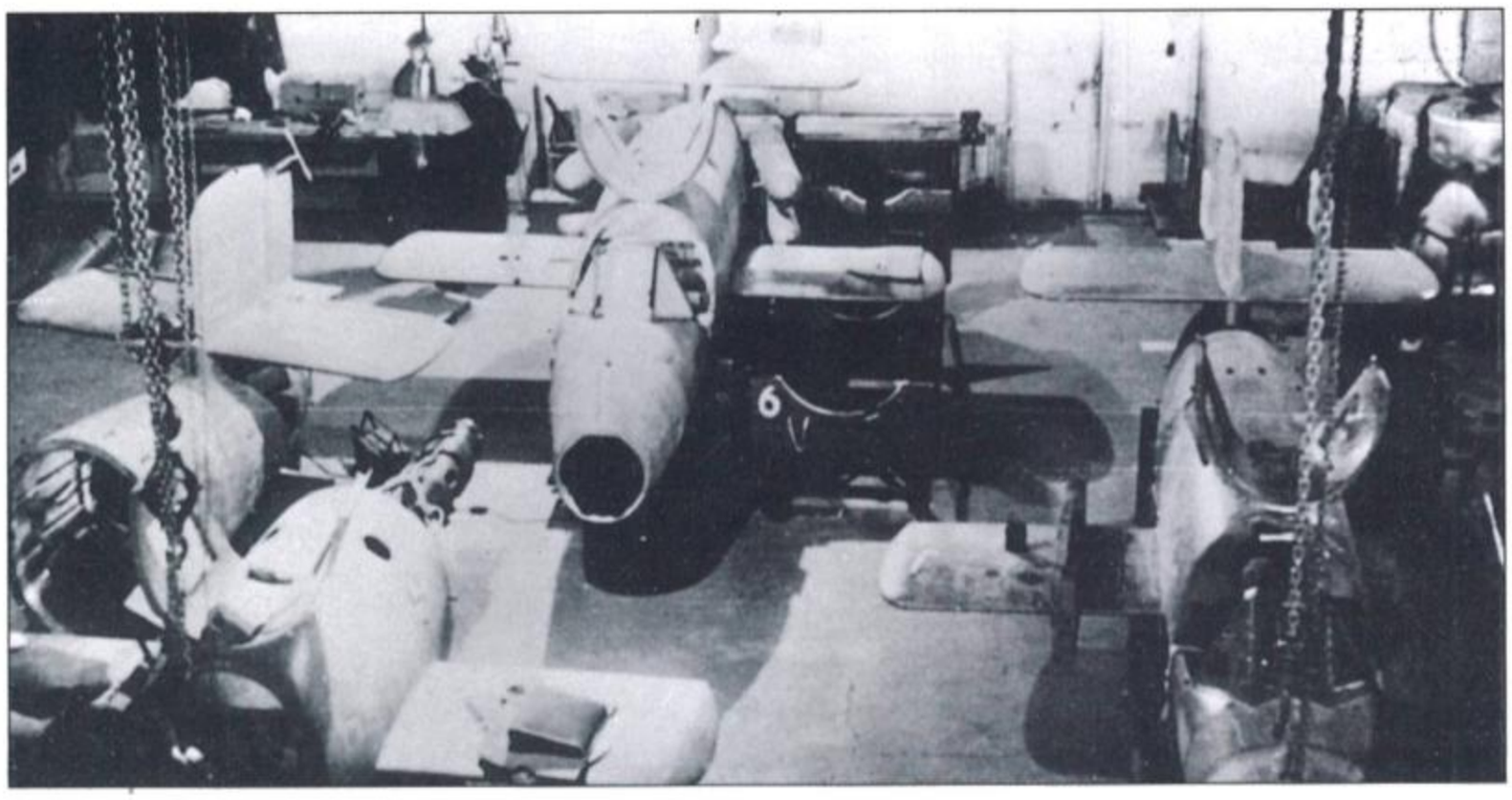
It was obvious that the era of precision missiles had made basing an air force on traditional airfields a nonsensical undertaking. The only way to deploy an air force that could survive in a war – the scenario was always an attack by the Soviet Union – was clearly to disperse it so widely, if possible into hidden locations, that it could not be eliminated in any pre-emptive strike. This meant that the aircraft had to be capable of VTOL, but they also had to be effective Mach 2 combat aircraft.

Post-war resurgence

Ernst Heinkel's reborn company began studying how the objectives could be achieved. The first study, completed in December 1957, was for a fighter standing upright on its tail, in the style suggested by SNECMA of France with the Flying Atar and the derived Coléoptère. This seemed impractical, and what appeared to be a better arrangement was seen in the Bell D-188A being developed for the USAF and Navy. This was to have two General Electric J85 turbojets pivoted to the wingtips, two fixed vertically in the forward fuselage and two, with afterburners, mounted in the rear fuselage. The D-188A was later given the USAF designation XF-109, although it was never completed.

This design looked attractive, but two of the engines could not be used for propulsion, and the two most powerful could not contribute to the lift. Accordingly, by June 1958 Heinkel had produced drawings of the He 231, a seemingly excellent solution. This was to be powered by

Dornier's Do 31E was designed to support VTOL fighter and strike aircraft operating in the field, but the designers had one eye on a perceived large civil market as well. Comparisons of direct operating costs killed the V/STOL airliner, and the few nations who purchased VTOL Harriers found that helicopters were adequate for the resupply mission.



The Natter could be built using the most basic of materials – pine, beech and plywood. Excluding a few metal parts, that which could not be glued together was nailed on, and a production Natter could be completed in 1,000 man-hours. Only three dozen were completed.

two pairs of identical turbojets, either from GE or Rolls-Royce, each engine being pivoted to the tip of a wing. Two were to be carried on a short-span forward wing and the other pair on the main wing, which to avoid the front jets was mounted higher.

By this time VTOL was fast becoming fashionable, but such an aircraft obviously posed a considerable design challenge. In view of this, in 1958 the Federal Defence Ministry in Bonn suggested that Heinkel should team up with Bölkow and Messerschmitt to produce the best aircraft. Accordingly, in January 1959 the three companies formed Entwicklungsring Sud (Development Group South), abbreviated as EWR. One of the first things EWR did was to send a team to Belfast to study the Short SC.1, which was then in hover testing. They returned convinced that they were on the right track, and also that the United Kingdom could make a major contribution to this and subsequent German programmes. This contribution was to include all the engines used, a great deal of the systems development, and much of the testing in wind tunnels.

The programme was given the designation VJ 101, from Versuchsjager (research fighter). The Heinkel configuration became the VJ 101A, the final A6 version having six of the projected Rolls-Royce RB.153 engines, four of

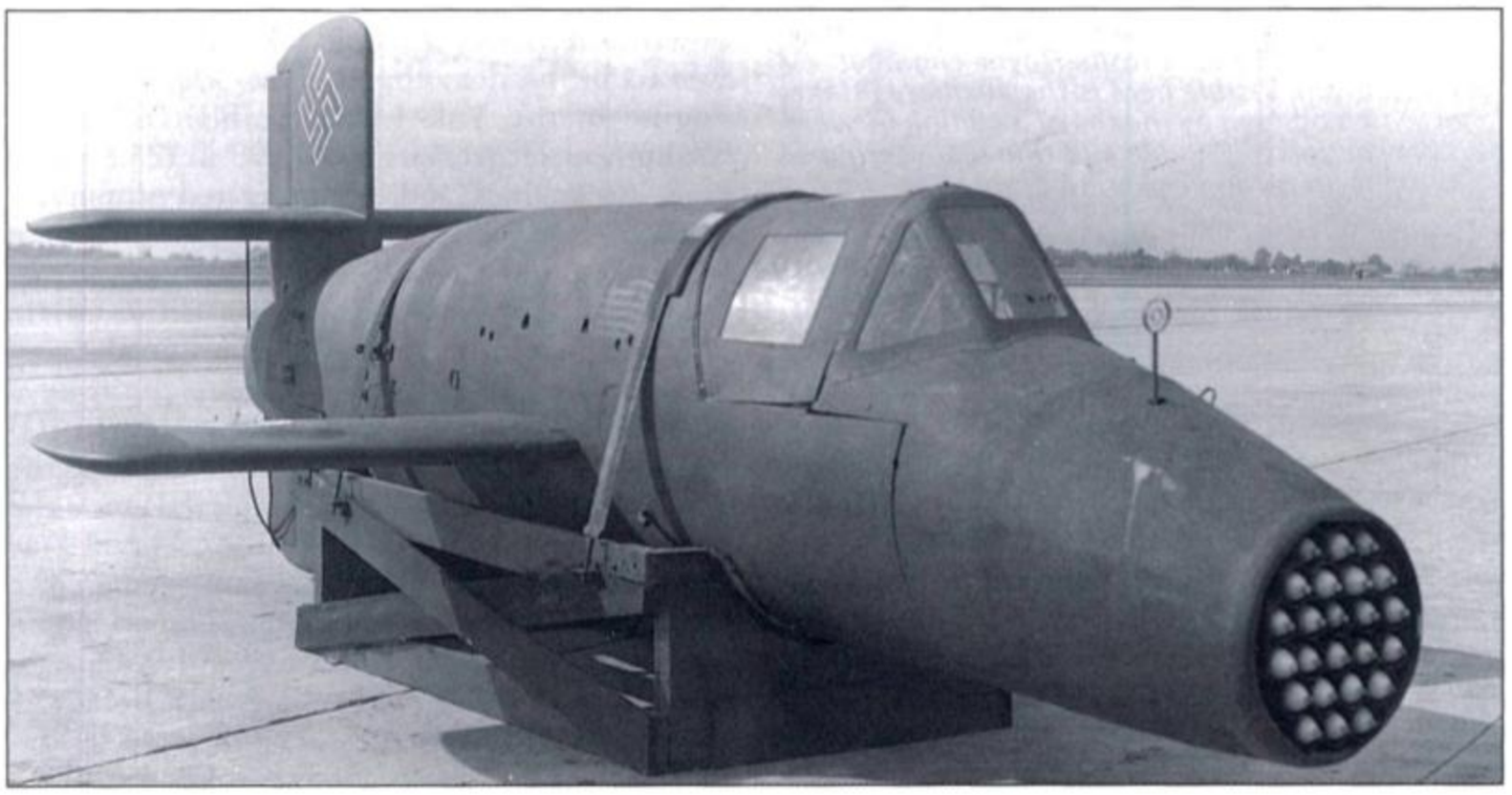
Below: The only known Natter pilot was Leutnant Lothar Siebert, who saw the rocket fighter as a precursor to future space travel and pestered Bachem until he was given the first manned test flight. He is seen here climbing in for his one and only flight. Shortly after launch, the canopy (attached with a simple furniture hinge) broke loose and struck Siebert, and the Natter plunged into the ground.

Specification

Bachem Ba 349A Natter

Type: single-seat interceptor
Powerplant: one 16.67-kN (3,746-lb) thrust Walter 109-509A-2 rocket motor and four 11.75-kN (2,640-lb) thrust Schmidding 109-533 booster rockets
Performance: (estimated) maximum speed 800 km/h (497 mph) at sea level; initial climb rate 11100 m (36,415 ft) per minute; service ceiling 14000 m (45,920 ft); radius of action at 12000 m (39,360 ft) 40 km (25 miles)
Weight: maximum take-off 2200 kg (4,850 lb)
Dimensions: span 3.60 m (11 ft 9.75 in); length 6.10 m (20 ft 0 in); wing area 2.75 m² (29.60 sq ft)

Above: In operational service it was planned to operate the Natter with untrained pilots, there being no need to master the business of take-off or landing. It is probably more fortunate from a German point of view that the one operational Ba 349 unit was overrun before any actual combat launches could take place.



A captured Natter in the USA displays its battery of 24 Föhn RZ73 73-mm (2.87-in) unguided rockets. This weapon load would have been devastating against an Allied bomber, but the likelihood of an untrained pilot reaching a firing position was low. The swastika marking is spurious – since the Natter was an expendable weapon, Hitler forbade the use of national insignia.

them in superimposed pairs in swivelling tip pods and the others on short struts instead of on a forward wing. It was soon evident that for low-level 'under the radar' cruise the engines would have to be throttled down to a thrust at which specific fuel consumption became unacceptably high. Ideally, only part of the installed thrust would be used for propulsion, the rest being provided by special lift engines used only for VTOL or hovering.

In March 1959 work was switched to the VJ 101B. This was a totally different and smaller aircraft with a delta wing, horizontal tail and all engines in the fuselage. Two RB.145s would provide propulsion and – using diverter valves and curved downward-pointing jetpipes – lift, supplemented for VTOL by a single RB.108 lift jet mounted at about 80°. By April the VJ 101B had been enlarged, the RB.108 now laying between two superimposed pairs of RB.153 engines with tail-end afterburners and diverter valves amidships for lift. The long jetpipes added weight and reduced thrust, and by September the main engines were much further back, their lift thrust being balanced by two of the new RB.162 lift engines behind the cockpit.

A major problem was the little room available for fuel and weapons. After agonising rethinks, it was decided to return to the original concept with pivoting engines on the wingtips, but with the necessary extra lift and balancing thrust being provided by fixed lift engines behind the cockpit. This appeared to provide the best compromise, with simple thrust-vectoring, the ability to vector engines with afterburners, no need for bleed-air reaction controls, and a simple airframe with the whole centre fuselage around the centre of gravity available for fuel.

In April 1960 it was decided to build two flight articles, the VJ 101C X1 for subsonic testing and the X2 with afterburning wingtip engines for Mach numbers around 1.2. These were preceded by novel rigs to help develop the control system. The first, the Wippe (see-saw), was a pivoted frame with a 2,340-lb (10.41-kN) RB.108 lift turbojet immediately behind the pilot seat. This rig was made in Germany and brought to Rolls-Royce's Hucknall test establishment. Testing began here on 10 May 1960, mainly in the hands of EWR's American chief test pilot George Bright, which proved that the RB.108 responded quickly enough to throttle demands to serve as the pitch control in hovering flight.

NATO requirement

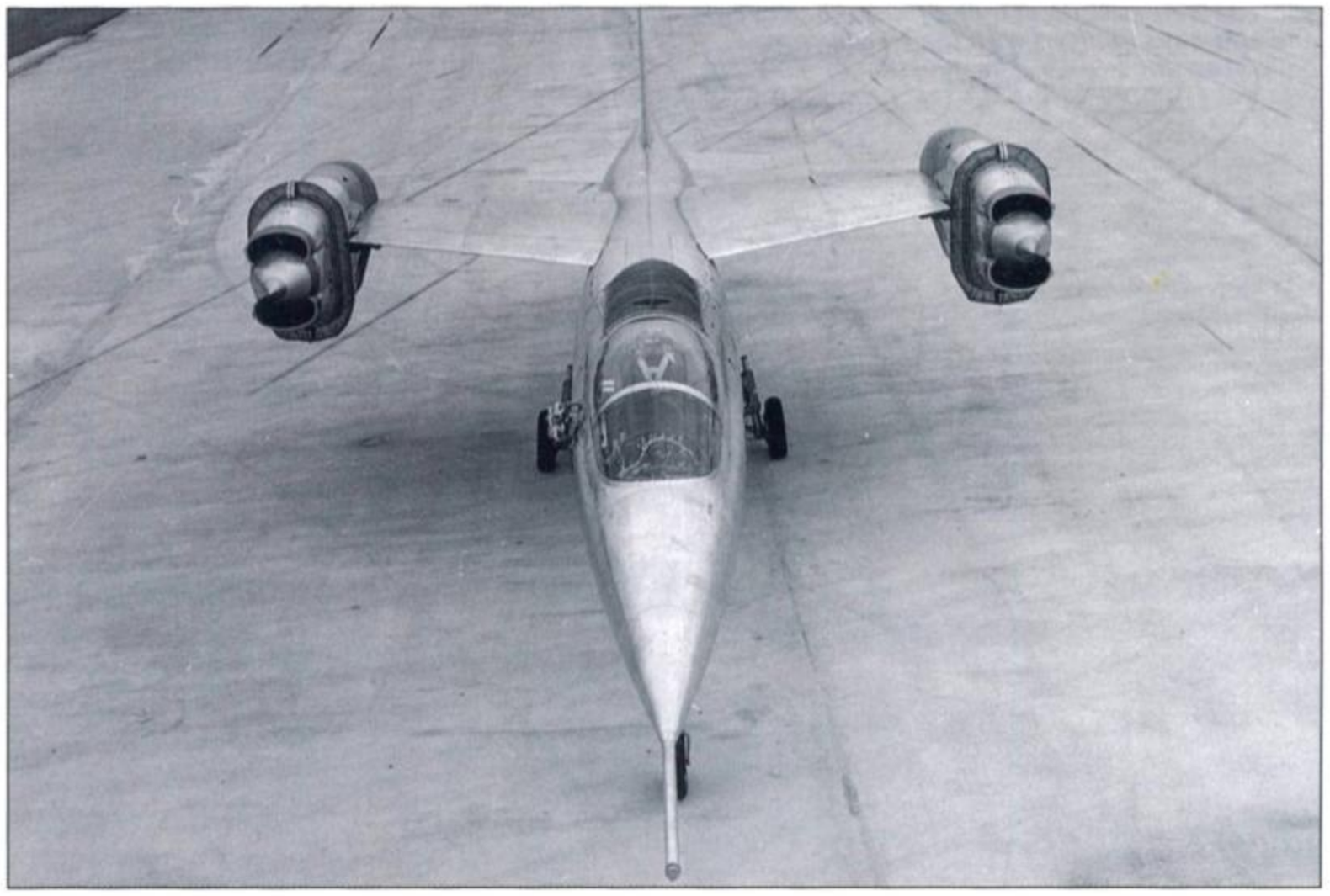
In August 1961 NATO Working Group AC.169 released NBMR-3 (NATO Basic Military Requirement No. 3). This called for a V/STOL fighter/reconnaissance aircraft for battlefield close support, able to be dispersed to hidden locations throughout a battle area. In November 1961 this was reissued as a Mach 2 replacement for the F-104G (AC.169a) and a Mach 0.92 replacement for the Fiat G91 (AC.169b). The VJ 101C met demand 169b.

Next, a more ambitious free-flying rig was built, the Schwebegestell hover rig. This comprised a steel-tube framework with the pilot and an RB.108 in the nose and an RB.108 on each side at the back, simulating the VJ 101C. This rig was first tested on 1 March 1962, pivoted to a telescopic vertical pillar at the EWR test centre at Manching, near Ingolstadt. Bright made the first free flight on 13 March 1962.

The intended engine for the production VJ 101C was the RB.153, but this advanced afterburning turbofan would take years to develop. Accordingly, the VJ 101C X1 was scaled down to match the RB.145, rated at 2,750 lb (12.23 kN) thrust. This meant it was a basically simple machine carrying only a pressurised cockpit with a Martin-Baker GA7 seat, and with telemetry in the nose instead of the planned radar. Structure was of light alloy with small amounts of steel or titanium. Honeywell provided an autopilot and Dowty-Rotol the hydraulic system for the flight-control power units, flaps, landing gear and tilting wingtip pods.

These pods were the only complex part of the aircraft. Each housed two engines, one above the other. Between them was a hollow shaft on which the pod pivoted on roller bearings under the thrust of a hydraulic ram and crank. At the front were supersonic-type inlets for each engine, separated by a large cone. For VTOL the complete inlet could be moved forward on hydraulic rams to leave a large gap (in hover testing, usually bridged by a gauze screen to prevent foreign-object damage) to admit extra air. The inlet was tested in a rig with a Nene engine sucking the air through.

Bright began testing the X1 pivoted to the vertical column on 19 December 1962. Free hover testing began on 10 April 1963, and the 13th such test, on 10 May, was attended by the Press, the aircraft having previously been a secret. On 29 August 1963 the aircraft made its



In this view, the VJ 101C bears a reasonably close resemblance to the F-104 Starfighter, a type that entered service in large numbers with the Luftwaffe during the early 1960s. The experimental fighter had five more engines than the Lockheed, and was considerably slower.

EWR's American test pilot George Bright chats by the first VJ 101 with Rolls-Royce engineer Alan Boulton. Visible here is the auxiliary intake slot which opened by means of a sliding forward intake section to provide additional air during ground running and hovering flight.

first CTOL (Conventional Take-Off and Landing) flight, becoming airborne at about 185 kt (343 km/h) after a run of 6,000 ft (1829 m). The landing was made at about 170 kt (315 km/h), the run being shortened by a braking parachute.

George Bright completed the main series of X1 testing between 8 October 1963 and the end of that year, in a series of flights which began with a VTO, transitioned in a forwards acceleration to wingborne flight and then, after high-speed manoeuvres, decelerated back to engine-supported flight to end with a VL. On 29 July 1964 the X1 reached Mach 1.04 in a shallow dive, but on 14 September of that year control was lost at a height of about 33 ft (10 m) and speed of 155 mph (250 km/h) during a conventional take-off. George Bright made a very smart ejection.

Just over one month later, on 27 October, testing began of the VJ 101C X2. Fitted with afterburning RB.145R engines in the swivelling pods, each rated at 3,550 lb (15.79 kN) static thrust, this was intended to be supersonic in level flight. It bore German civil registration D-9518. X2 testing began in the CTOL mode, and level Mach number eventually reached 1.14. In the VTOL mode the velocity and temperature of the afterburning jets caused some difficulty, and in any case the pressure to hasten development of the VJ 101 had abated. It was obvious that the basic design was much too limited to become the basis for a fighter, and it was reluctantly concluded that much more powerful tip-mounted engine pods would be difficult to accommodate in the vertical mode. Such pods could not readily be pivoted at the back, and with the pivot in an acceptable location there would not be adequate vertical distance in the VTOL mode between the afterburner nozzles and the ground. Thus, the seemingly attractive idea of pivoting engine pods reluctantly had to be abandoned.

Accordingly, test flying was temporarily suspended while design went ahead on the proposed definitive strike fighter, the VJ 101D. This marked an exact return to the configuration of the VJ 101B. It would have had two RB.153-61 lift/cruise engines in the fuselage and five RB.162-32 lift jets in a row behind the cockpit. The RB.153 was a slim augmented turbofan, each rated at 12,100 lb (53.83 kN) thrust with maximum afterburner, the rear jetpipes comprising rotating tapered sections to vector the nozzle from 0° to 90° downwards. Over 25 years later the same idea was to be used in the R-79V-300 lift/cruise engine of the Yak-141. The RB.162 was a totally new lift jet, rated at 5,200 lb (23.13 kN) each. All engines, and the integrated propulsion system, were being developed by Rolls-Royce in partnership with the German MAN company.

Meanwhile, the VJ 101C X2 resumed flying in December 1970 to help develop the fly-by-wire flight-control system of the VAK 191B (see below) and the MRCA, which became the Tornado. This work was completed with the programme's 325th flight on 27 May 1971. Subsequently, the aircraft was placed in the Deutsches Museum in Munich. The proposed VJ 101C X3 dual trainer and VJ 101 X4A with two pivoted RB153-61 and two RB.162-34 engines were never built.

The VJ 101C programme had yielded much data, and also solved difficult problems, such as how to design supersonic inlets which could tilt through 90°. Unexpectedly, one of the few tangible results was that the perfect performance of the ejection seat in a real emergency spurred the fitting of Martin-Baker Mk 7 seats to Luftwaffe F-104G fighters.

The VJ 101C X1 is seen before its 13th flight with mesh guards on all but the forward intakes. The tilting wingtip engines would have permitted short as well as vertical take-offs, but backwards and sideways flight as with the Harrier would have been impossible. The question of 'VIFFing' was not explored during the test programme.

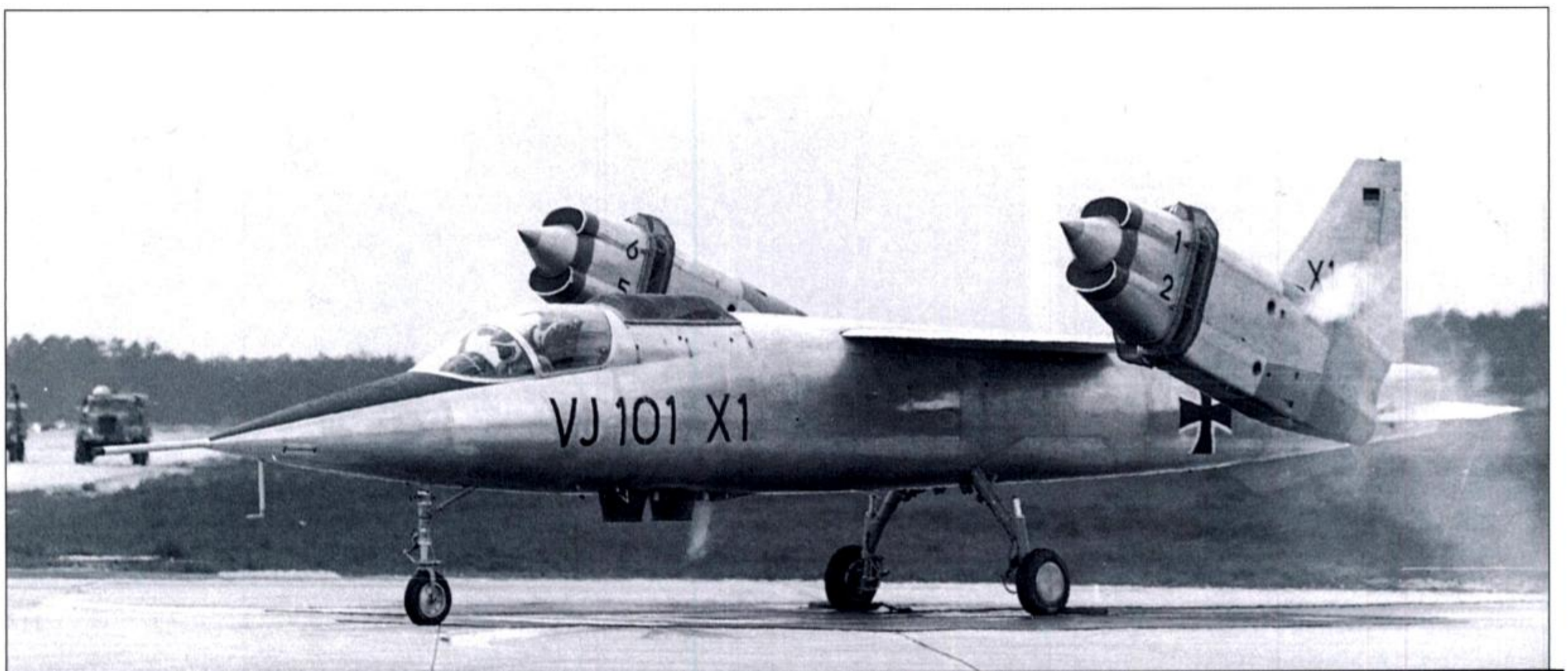
Dornier Do 31

As soon as the manufacture of aircraft was once again permitted in Federal Germany, in 1955, the resurrected Dornier AG at Friedrichshafen began design of a small utility aircraft with outstanding STOL (Short Take-Off and Landing) properties. This machine, the Do 27, first flew in 1956, and over 600 were

Specification

EWR VJ 101C

Type: single-seat VTOL research aircraft
Powerplants: six Rolls-Royce/MAN RB.145 turbojets, each with 12.23 kN (2,750 lb) thrust (X1); X2 had four 15.79-kN (3,550-lb) thrust RB.145s with afterburning in wingtip pods
Performance: maximum speed,(X1) Mach 1.08, (X2) 1.14
Weight: maximum take-off (X1) 6000 kg (13,228 lb), (X2) 8000 kg (17,637 lb)
Dimensions: span 6.61 m (21 ft 8.25 in); length 15.70 m (51 ft 6 in); height 4.13 m (13 ft 6.5 in); wing area 18.60 m² (200.2 sq ft)



built. From it was derived the twin-engined Do 28 and the larger Skyservant, both of which were also built in quantity.

In 1957 work began on an experimental aircraft derived from the Do 27 with even more outstanding STOL performance. The resulting Do 29, first flown in December 1958, was fitted with twin engines driving pusher propellers which, for take-off and landing, could be pivoted down at an angle up to 90°. The Do 29 could fly under control at only 40 mph (64 km/h).

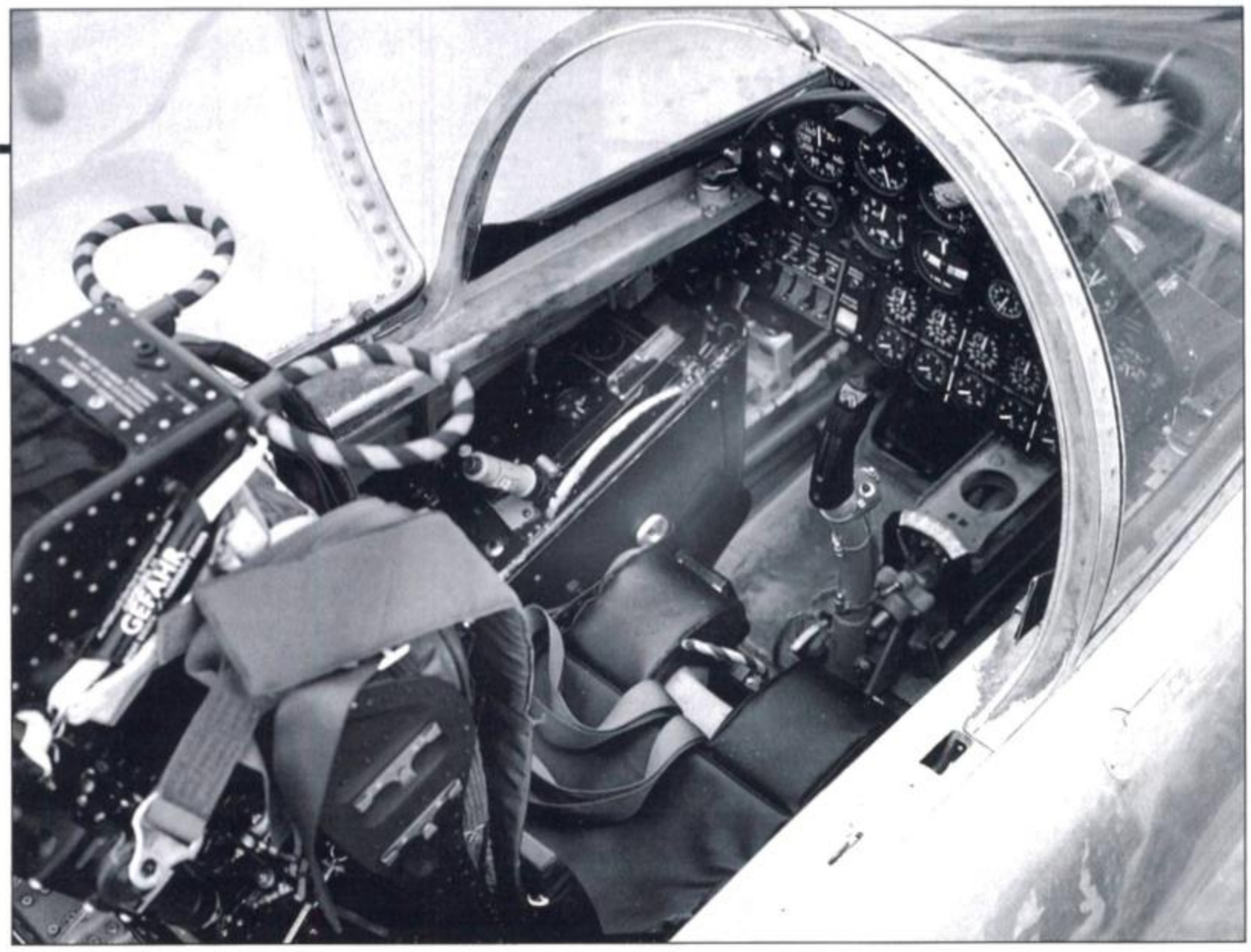
It was clear to Dornier that the next step would be the development of true V/STOL transports powered by jet engines. Studies began before 1960, but it was early 1962 before British companies Rolls-Royce and Bristol Siddeley made it clear that suitable engines would be forthcoming. It was also in 1962 that NATO published the NBMR-4 (NATO Basic Military Requirement) specification for a jet-lift transport to support the eventual NBMR-3 V/STOL strike fighter in operations from dispersed bases. Accordingly, in February 1962 Dornier began full engineering development of the Do 31 jet V/STOL transport.

Hovering rigs

Initially, the Federal Ministry of Defence placed a contract – for what today seems a very modest amount, DM220 million (£28.2 million, $42.3 million) – for a Small Hovering Rig, a Large Hovering Rig and three Do 31E experimental prototypes: E-1 and E-3 for flight and E-2 for static test. The Small Rig comprised a steel-tube spaceframe in the form of a cross, similar to the first rig in the VJ 101C programme, but larger, with a 'span' of over 40 ft (12.2 m) and length of 60 ft (18.3 m). Four RB.108 turbojets were distributed across the transverse girder, and the cockpit was in the nose. Vertical velocity was controlled by modulating thrust of the inboard engines, pitch control by bleed-air reaction jets at the tail, roll by differential modulation of thrust of the outboard engines and yaw by swivelling the outboard engines in opposite directions. This rig weighed just over 5,000 lb (2268 kg) and first operated in April 1964.

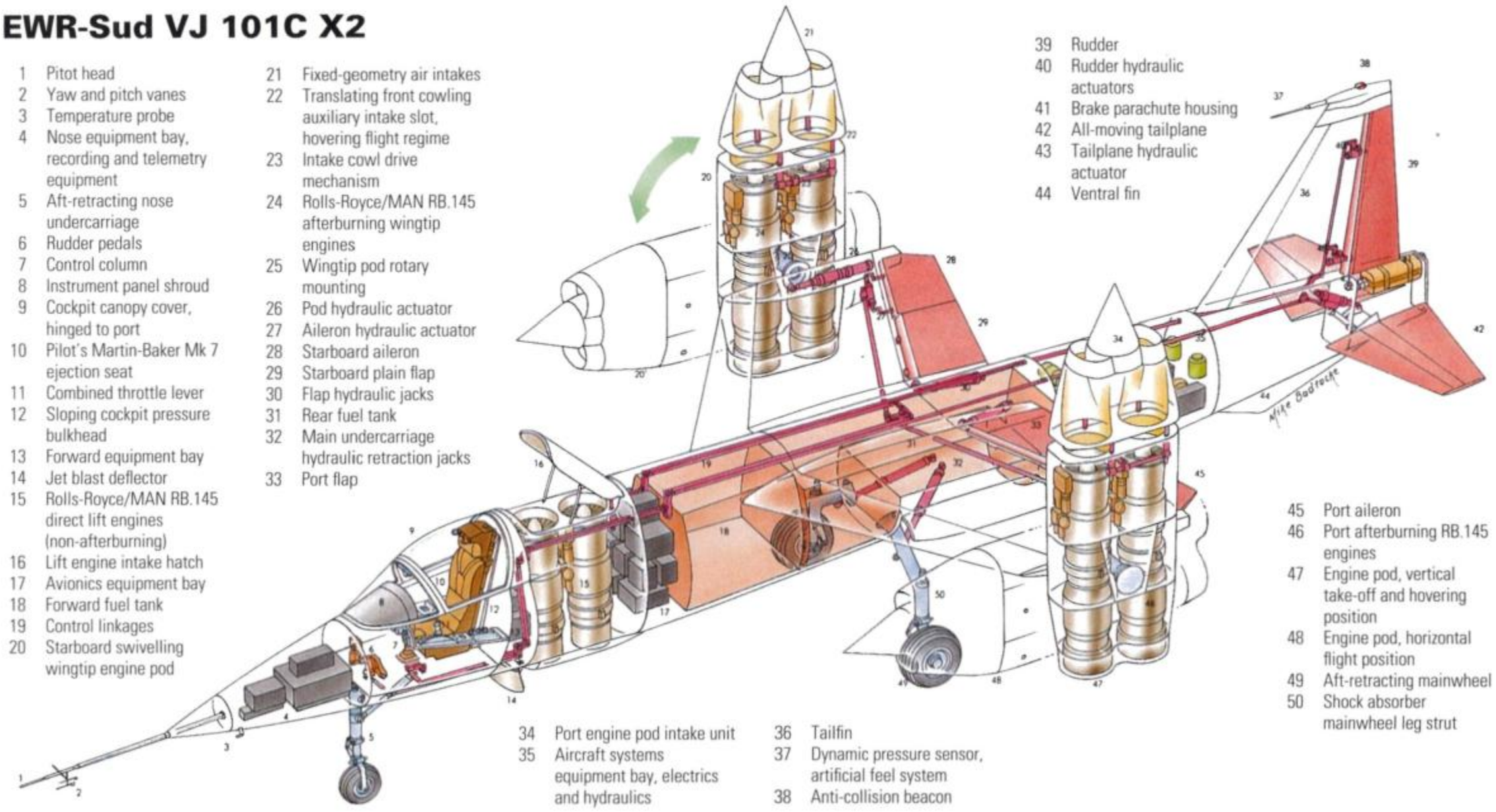
In May 1965 Dornier and Britain's Hawker Siddeley Aviation announced that the two companies were collaborating in the development of an advanced V/STOL jet-lift transport, with the agreement (but no contract) of their two governments. In 1962 the British firm had completed study of its NBMR-4 submission, the attractive Hatfield- (de Havilland) based HS.129. This was the basis of the proposed Dornier Do 231 family, for which the Do 31E was to provide the underpinning of test experience.

The Large Hovering Rig first operated in February 1967. Essentially a 'boilerplate' model of the Do 31E, it comprised a crudely made forward fuselage housing the nose compartment for side-by-side pilots, a stubby high wing carrying two lift/cruise engines inboard and two lift-jet pods on the tips, and a rudimentary rear structure, without a tail, to carry the bleed-air jets needed for pitch control. The main engines were Bristol Siddeley Pegasus 5 turbofans, each rated at 15,500 lb (68.95 kN),



The cockpit of the VJ 101 was almost entirely conventional. A single throttle lever controlled all six engines. Test pilot George Bright had cause to use the Martin-Baker ejection seat when the X1 lost control at an altitude of 10 m (30 ft) following a horizontal take-off.

EWR-Sud VJ 101C X2



1 Pitot head
2 Yaw and pitch vanes
3 Temperature probe
4 Nose equipment bay, recording and telemetry equipment
5 Aft-retracting nose undercarriage
6 Rudder pedals
7 Control column
8 Instrument panel shroud
9 Cockpit canopy cover, hinged to port
10 Pilot's Martin-Baker Mk 7 ejection seat
11 Combined throttle lever
12 Sloping cockpit pressure bulkhead
13 Forward equipment bay
14 Jet blast deflector
15 Rolls-Royce/MAN RB.145 direct lift engines (non-afterburning)
16 Lift engine intake hatch
17 Avionics equipment bay
18 Forward fuel tank
19 Control linkages
20 Starboard swivelling wingtip engine pod
21 Fixed-geometry air intakes
22 Translating front cowling auxiliary intake slot, hovering flight regime
23 Intake cowl drive mechanism
24 Rolls-Royce/MAN RB.145 afterburning wingtip engines
25 Wingtip pod rotary mounting
26 Pod hydraulic actuator
27 Aileron hydraulic actuator
28 Starboard aileron
29 Starboard plain flap
30 Flap hydraulic jacks
31 Rear fuel tank
32 Main undercarriage hydraulic retraction jacks
33 Port flap
34 Port engine pod intake unit
35 Aircraft systems equipment bay, electrics and hydraulics
36 Tailfin
37 Dynamic pressure sensor, artificial feel system
38 Anti-collision beacon
39 Rudder
40 Rudder hydraulic actuators
41 Brake parachute housing
42 All-moving tailplane
43 Tailplane hydraulic actuator
44 Ventral fin
45 Port aileron
46 Port afterburning RB.145 engines
47 Engine pod, vertical take-off and hovering position
48 Engine pod, horizontal flight position
49 Aft-retracting mainwheel
50 Shock absorber mainwheel leg strut

Beyond the Frontiers

The VJ 101 was nicknamed 'Traumjäger' ('Dream Fighter') due to its futuristic appearance, although hopes of the type becoming a successful combat aircraft turned out to also be dreams.

with four vectored thrust nozzles. These engines were similar to those which powered the Hawker Siddeley Kestrel, predecessor of the Harrier. The pods on the wingtips each housed three RB.162-4D lift jets, each rated at 4,400 lb (19.57 kN). Thus, total available lift thrust was 57,400 lb (255.34 kN), compared with a flying weight of about 34,000 lb (15422 kg).

The Large Rig was intended to develop the propulsion and flight control system in the VTOL mode. As it was not expected ever to exceed an airspeed of 40 kt (74 km/h) it was simpler and lighter than the Do 31E, giving an exceptional margin of thrust over weight. Very simple hydraulic and electric power systems were installed, the landing gears were fixed, the ailerons and flaps were inoperative, and there were no tail surfaces.

Although the Large Rig could taxi, it began testing with over 100 'flights' attached to the vertical telescopic hydraulic strut, as in the VJ 101C programme. Lift control was achieved by modulating thrust of the main engines, roll was governed by differentially modulating the lift engines, yaw by differentially pivoting deflector rings on the nozzles on these engines (hydraulically driven under control from the pilot's pedals), and pitch as before by reaction control jets at the tail, fed with air bled from the main lift/cruise engines.

Following the 100 captive tests, the Large Hovering Rig made its first free flight on 7 February 1967. Subsequently, it was intensively operated in developing the complete control system for V/STOL flight. Only two days after its first free flight the Do 31E-1 also began its flight-test programme. This looked like the definitive Do 31E, and carried civil registration D-9530, but it had no lift jets in conventional mode. Of course, take-off and landing speeds were rather high, but a great deal of useful flying was done. It soon reached Mach 0.67 (about 400 kt, 735 km/h), an indicated speed of 325 kt (602 km/h) and a height of 33,000 ft (10000 m). On Flights 12/13 it was ferried from Munich to the 1967 Paris air show.

Hovering airlifter

The Do 31E-2 was eventually tested to destruction in the static airframe rig. The Do 31E-3, the fully equipped V/STOL machine with operative lift-jet pods, began test flying on 14 July 1967. Just as all the VJ 101C test flying was done by George Bright, so another American, Drury W. Wood, was responsible for the Do 31 flight-test programme, although altogether the flight-test team eventually grew to 49 personnel. The E-3 began its flight programme in the CTOL mode. It accomplished the first take-off transition – the flight comprising a VTOL, accelerating transition to wingborne flight, circuit and CL – in November 1967. The first landing transition, comprising a CTO, circuit, decelerating transition to jet-supported flight and VL, followed in December. Finally, the first complete flight, with a VTO, high-speed flight and VL, was accomplished in January 1968.

By this time the US National Aeronautics and Space Administration (NASA) had become interested in the Do 31E. Airport congestion, both on the ground and in terminal airspace, was at that time leading to urgent study of jet-lift V/STOL airliners, and the Dornier company was the only one in the world with experience of flight hardware in this category. At the beginning of 1969 agreements were drawn up between NASA, the Federal German government and Dornier for a joint programme, basically for NASA personnel to use Dornier's facilities and hardware.

The Dornier/NASA programme began in March 1969 with pilots simulating the German aircraft at NASA Ames Research Center using a cockpit with 6° of freedom, a digital and an analog computer with suitable software, and Redifon displays. Conversion of the NASA team for flying the Do 31E-3 was completed in September 1969, the chief NASA pilot being Robert C. Innis. In the same month most of the NASA team moved to Dornier's Oberpfaffenhofen test airfield, where NASA research with the German aircraft was completed by mid-1970.

Most of the effort of the joint programme was directed towards the evaluation of trajectories, procedures, cockpit displays and ground electronic aids for a future network of V/STOL scheduled services. Earlier, in June 1969, the E-3 had made a simulated airline-type flight from Munich to the Paris air show, with a payload, flying under IMC (instrument meteorological conditions) and ending with a penetration and ILS (instrument landing system) approach to a VL. Much work was subsequently carried out, mainly by NASA, on an all-weather guidance and traffic control system for jet V/STOLs.

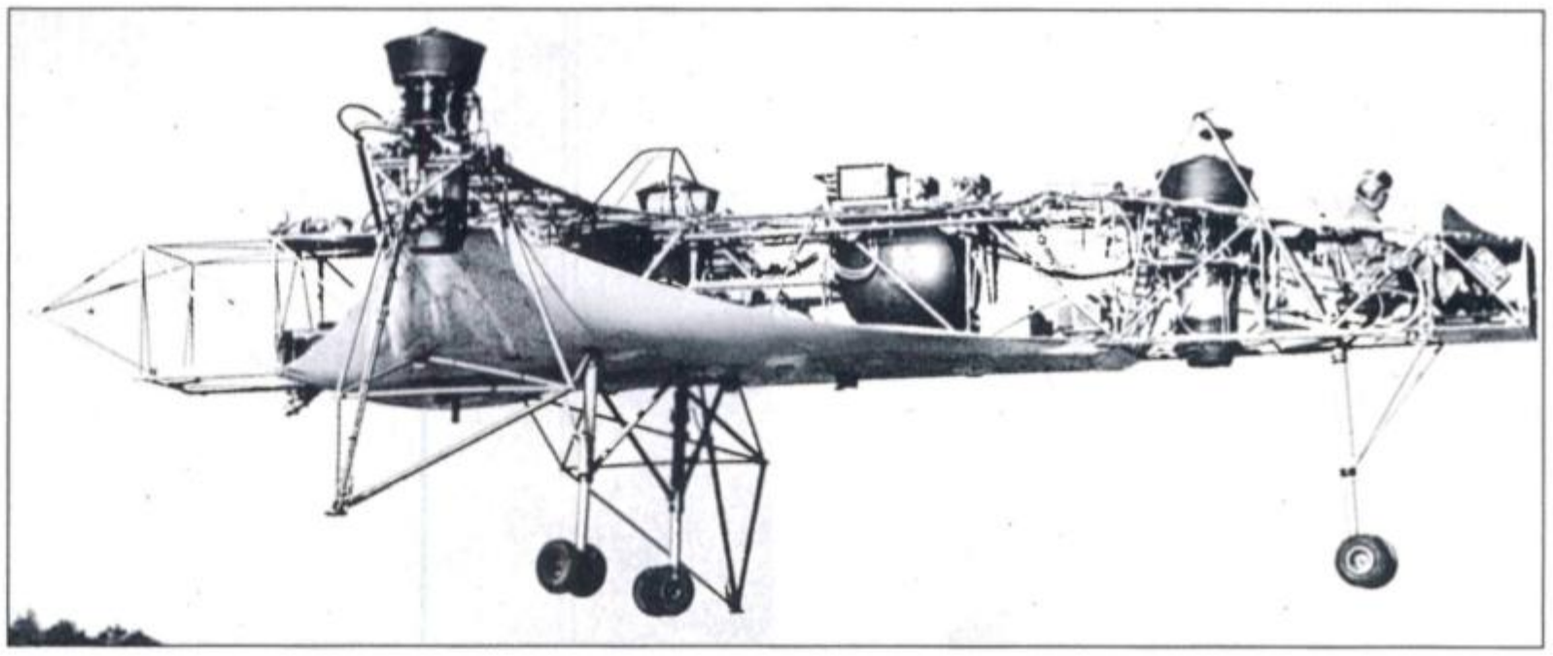
Meanwhile, Dornier refined the design of the proposed Do 231. This was to be a 130,000-lb (58968-kg) aircraft, seating 100 passengers and looking like a stretched and more streamlined version of the Do 31E. Lift/cruise engines were to be RB.230 turbofans each rated at 24,000 lb (106.76 kN). Lift engines were to comprise 12 RB.202 turbofans, each with a bypass ratio of 9.5 to reduce noise, with a rating of 13,100 lb (58.27 kN). Thus, gross lift was to be 205,200 lb (93079 kg). The Do 231 was to have a range with maximum payload of 621 miles (1000 km), and a cruising speed of

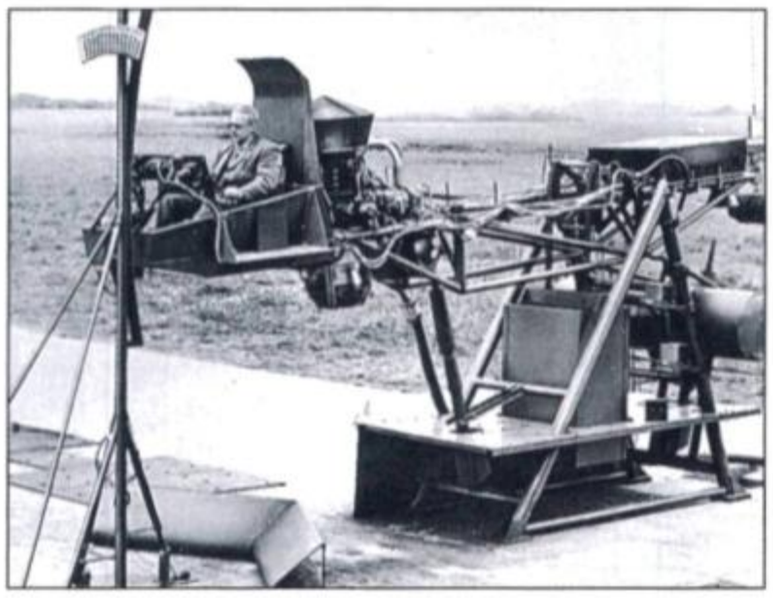
Above: The rarely photographed VJ 101 X2, seen here at a Manching open day in 1971, was equipped with afterburners on the four podded engines. The lengthened nacelles were the only major visible difference between the two prototypes.

Below: Unusually for an aircraft designed for VTOL operations, the VJ 101 was fitted with a large-diameter brake chute, which was used for conventional landings. The X1 was lost following a conventional take-off, but the X2 is today preserved at the Deutsches Museum in Munich.

'Flying bedsteads'

As with the British VTOL research programme, the Germans utilised purpose-built rudimentary aircraft (known in Britain as 'Thrust Measuring Rigs') to test engine layouts and to develop flight control systems and flying techniques for hovering flight. Each of the three post-war jet VTOL projects had its own 'flying bedstead' which, while bearing little resemblance to the aircraft which they were supporting, contributed much useful data.

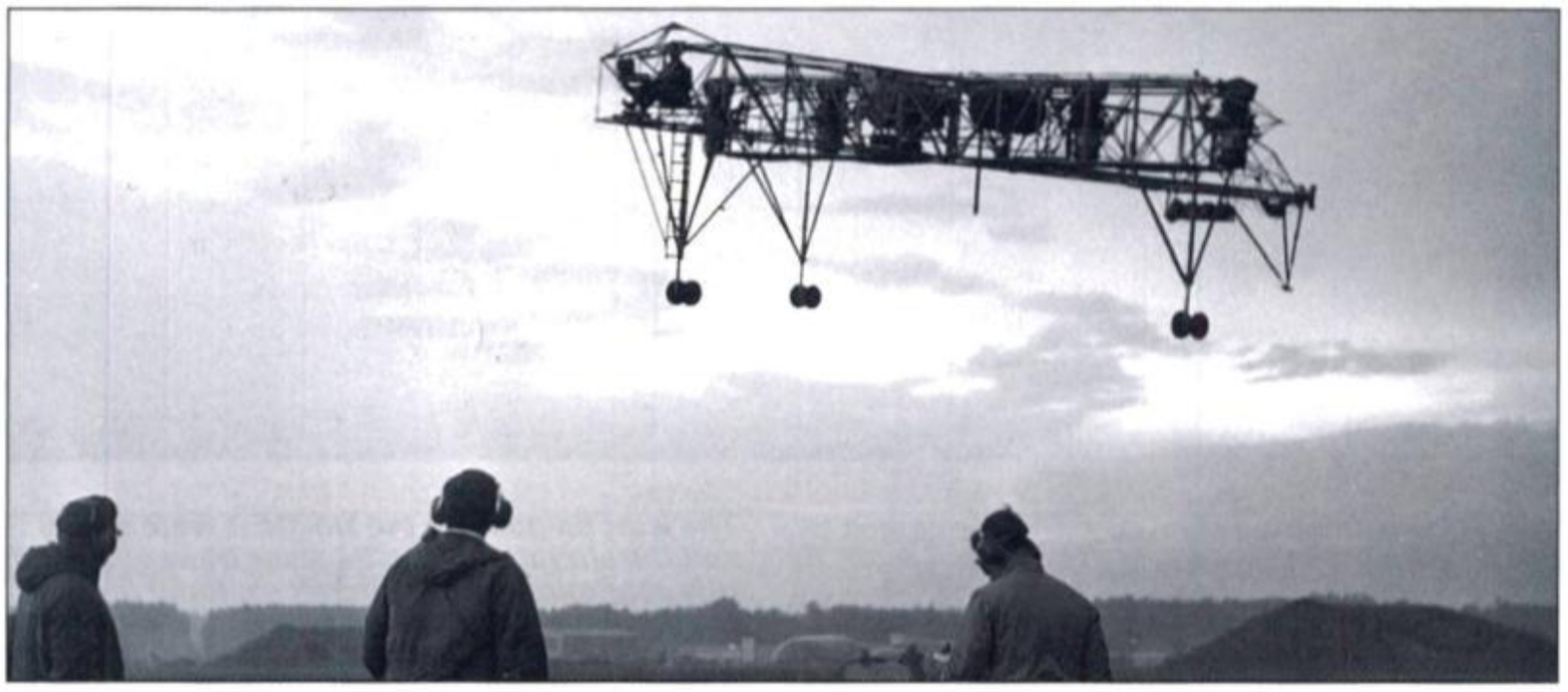




Above: The next stage in the VJ 101 programme was a hovering rig. Unlike the Wippe, which could only simulate one axis at a time, the rig was controllable in roll, pitch and yaw. A dummy wing surface was fitted under the rig.

Left: This extraordinary device, reminiscent of an H. G. Wells time machine, was the Wippe (see-saw) and was used to refine the control system for the VJ 101C. The 'pilot' controlled the pitch angle of the rig by varying the throttle on the RB.108 engine mounted behind his seat.

Above: The VAK 191 rig (known by the overall project name of SG 1262) featured a row of five RB.108 engines spaced along the 'fuselage'. It also flew with the cockpit faired in a more representative shape.



Left: The largest of the jet 'bedsteads' flown for the German VTOL research programme was the 'small hover rig' for the Dornier 31, although it was smaller than the Do 31 itself. It completed a total of 247 free flights as well as many tests fixed to a pedestal. Four RB.108s provided lift.

559 mph (900 km/h).

Military versions were also projected. There is no question that the Do 231, and corresponding British projects such as the slightly larger Hawker Siddeley HS.141, would have been entirely feasible. Nevertheless, the appeal of both civil and military jet-lift V/STOL aircraft gradually waned, because of a shift in fashion and perceived need.

In the case of civil aircraft, the chief killer was the fact that direct operating costs (DOCs) were bound to be higher than those of CTOLs. Studies showed that the Do 231 would have DOCs roughly 40 per cent higher than those of a B.737 on a stage-length of 230 miles (370 km), falling to 23 per cent higher on a stage length of 578 miles (930 km). In addition, it was recognised that a V/STOL airport could not be sited on city rooftops, as once had been imagined, but would have to be almost as large as a CTOL airport.

In the case of military V/STOLs the near-total disinterest of the USAF, which had never suffered destruction of its air bases and consistently failed to consider the possibility of such an event, has led to the Harrier II and Sea Harrier being the only aircraft in the modern world which could continue operating on day two of a war between major powers. However, the Do 31/Do 231 were by no means the last of the German jet V/STOL aircraft.

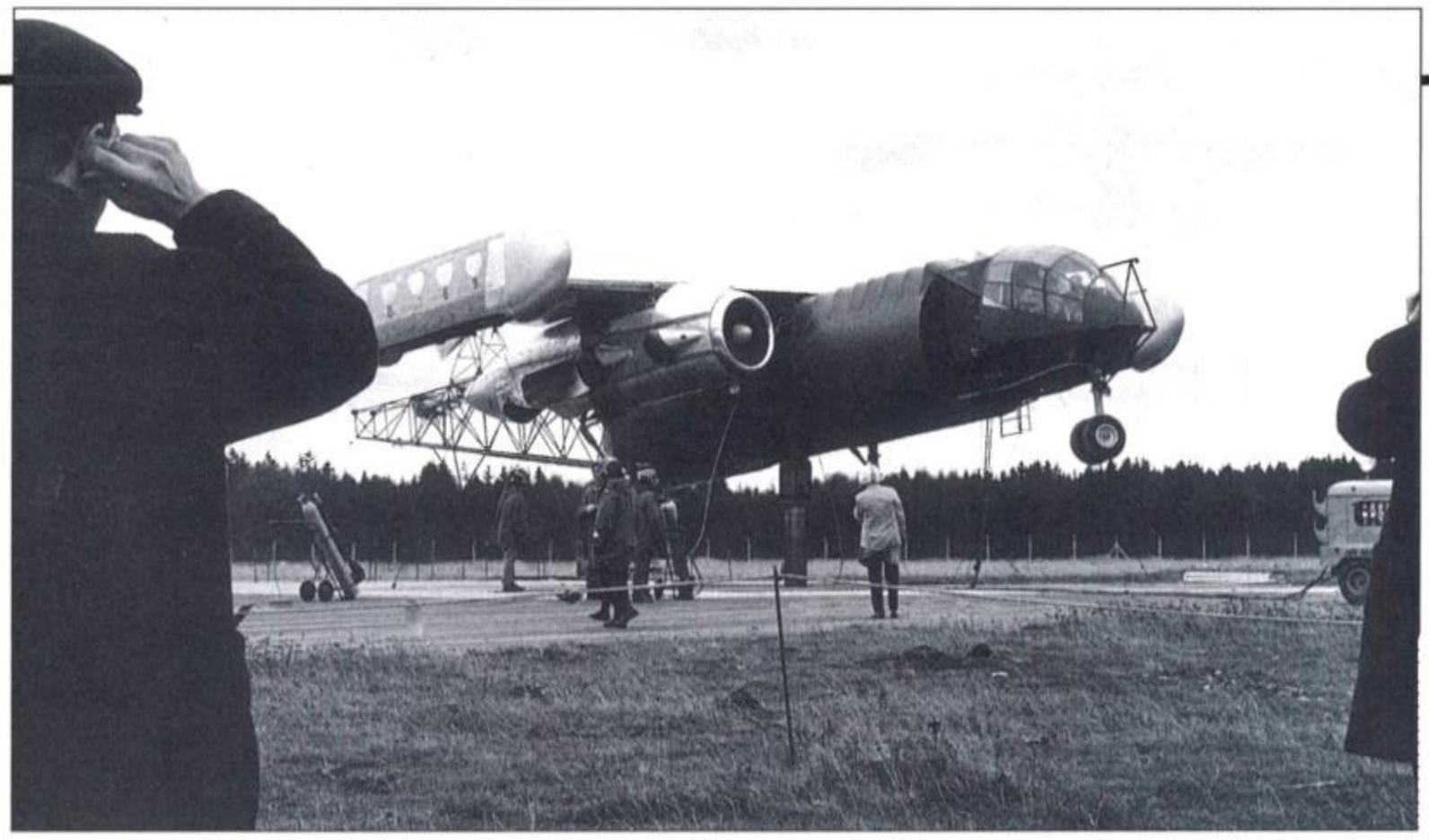
VAK 191B

Whereas the VJ 101C had an ancestry dating back to the late 1950s, further jet V/STOL aircraft were triggered by the issue in November 1961 of requirement NBMR-3/169b, to find a replacement for the Fiat G91. These comprised the EWR 420, the Focke-Wulf Fw 1262 and the Italian Fiat G95/4. The existing British Hawker P.1127 was included in subsequent evaluations as a reference for comparison. The requirement called for the ability to operate from semi-prepared sites, with no ground facilities except fuel and ordnance, and to make a VTO and then fly at 500 ft (152 m) altitude at Mach 0.92 over a radius of 250 nm (463 km) carrying a weapon load of 2,000 lb (907 kg), finally returning to a VL.

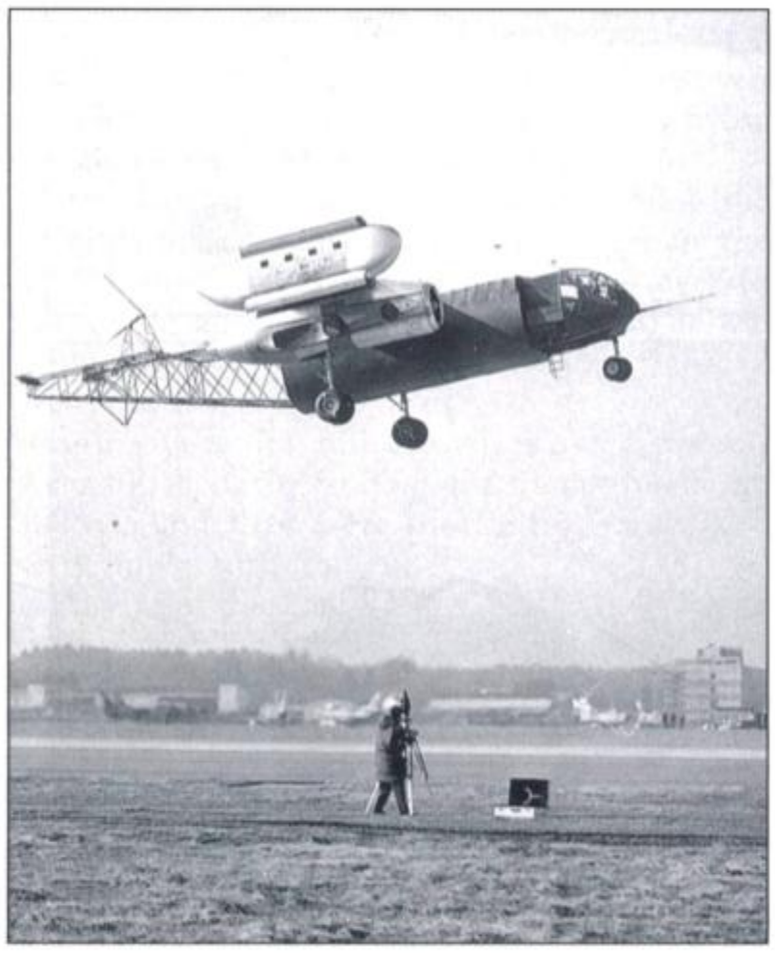
Subsequently, the spotlight focused briefly on the 169a requirement for a Mach 2 aircraft to replace the F-104G; it was won by the Hawker P.1154 but France claimed the Dassault Mirage III-V was 'of equal merit'. This led to much wasted effort, and these projects came to nothing. Most NATO countries were mere spectators, but in May 1963 the German and Italian governments – those that actually used the Fiat G91 – decided jointly to go ahead with a 169b aircraft.

They called the refined requirement VAK 191, from Vertikalstartendes Aufklärungs- und Kampfflugzeug (vertical take-off reconnaissance and battle [i.e., attack] aircraft), the number indicating that it was to succeed the G91. The evaluation compared the VAK 191A (P.1127), 191B (Fw 1262), 191C (EWR 420) and 191D (G95/4). The engines offered were the Bristol Siddeley BS.94/3 lift/cruise engine, the Rolls-Royce RB.153–61 or –75 propulsion engine (with or without afterburner) and the Rolls-Royce RB.162 lift jet.

The EWR and Fiat aircraft were almost identical in configuration, with four lift engines in a row between the inlet ducts and two propulsion engines with nozzles at the tail. The EWR was derived from the VJ 101D. The Focke-Wulf differed in having a single lift/cruise engine amidships with four vectored nozzles (as in the P.1127) and just two additional lift jets, one ahead of and the other



Right: One aspect common to all VTOL jets is extreme noise levels. Following the success of the 'small hover rig', the 'big rig' was constructed as a virtual prototype of the Do 31 itself, with only the rear fuselage and tail unrepresentative of the final configuration. The 'big rig' is seen here undergoing captive tests on the 'telescope'.



Above: Dornier's 'big rig' first flew in February 1967 and was designed only for hovering flight. Due to its lower weight as compared to the actual Do 31, only six lift engines (rather than eight) were fitted, in addition to the two Pegasus propulsion engines. The test programme of the 'big rig' was essentially completed in 17 free flights.

The wingtip pods on the Do 31E-1 were empty and the aircraft flew on Pegasus power alone. In this configuration the aircraft explored the conventional envelope and paved the way for the subsequent E-3 to investigate all flight regimes. A third complete Do 31 was built, the E-2, which was tested to destruction in the static rig.

behind the main engine. Basic parametric calculations appeared to show that, to meet the mission requirement, the aircraft's take-off weight would be a minimum if the lift jets provided about half the total installed vertical thrust. Since this condition was best satisfied by the Fw 1262, it was this aircraft, as the VAK 191B, that was selected as the winner in August 1963. The officials were satisfied that the approximately 10,000 lb (45 kN) of thrust of the BS.94/3 would suffice for Mach 0.92 cruise at low level.

By this time it was clear, at least to a bystander, that the NATO officials were much happier producing talk and paper reports than flying hardware. In November 1963 the British Ministry of Defence evaluated the VAK 191B with a view to joining the programme. In June 1964 the VAK 191B, and its rivals, were evaluated by the USAF's Systems Command, although without them having the slightest intention of becoming involved. The situation was further confused by the formation in December 1963 of Vereinigte Flugtechnische Werke (VFW) by the merger of Focke-Wulf and Weser, plus other shareholders including United Aircraft (which brought in Pratt & Whitney and Sikorsky) and Friedrich Krupp.

Not until July 1965 did the German and Italian governments at last sign an agreement for joint development of the VAK 191B. The work was split 60 per cent to Germany and 40 per cent to Italy. A bilateral programme management committee was set up, followed by a complicated two-nation management structure with numerous working groups. The decision was taken to build six flight articles, three of them dual-control two-seaters.

The airframe prime contractors were named as VFW and Fiat. To Bristol Siddeley's chagrin the lift/cruise engine was selected as a Rolls-Royce design, the RB.193-12, based on the same concept as the BS.94 and Pegasus with four swivelling nozzles. This was to be developed mainly with German funds and produced jointly by MAN and Rolls-Royce. Almost all the complex systems and equipment were contracted for in Britain and the USA, except for the APU (auxiliary power unit) by Klockner-Humboldt-Deutz and the flight control system and autopilot nominally produced by VFW and Bodenseewerke.

Control system development

In order that the flight-control system, including autostabilisation and the autopilot, could be developed in advance, the German government unilaterally contracted for a free-flight hovering rig, designated SG 1262. This bore no relation to the VAK 191B except that it incorporated the actual units of the flight-control system and a simulated cockpit which later offered the same pilot field of view. A long steel-tube girder, without lateral projections other than short roll-control arms, it was supported by a row of five RB.108 engines along the centreline, with bleed-air manifolds to the reaction-control jets. Thus, installed thrust was about 10,500 lb (46.71 kN) allowing for airbleed, giving a useful margin over the rig's weight of 8,600 lb (3900 kg); this fell to only 6,835 lb (3100 kg) when the two fuel tanks became exhausted after 12 minutes of hovering.

The SG 1262 was constructed at the former Focke-Wulf factory at Bremen, and began operating on a pivoted attachment to a telescopic vertical pylon, in principle similar to that used by EWR-Sud at Manching. It began free hovering in the hands of VFW chief test pilot Ludwig Obermeier on 5 August 1966. The rig was operated for 18 months, for development of the flight-control hardware, refinement of optimum departure and approach trajectories, and switch-over to manual control or automatic rate control. Later the rig was also flown by Fiat pilots Pietro Trevisan and Manlio Quarantelli.

Design and manufacture of the VAK 191B flight articles began in 1965 and was expected to be completed in early 1968. The accompanying test programmes were particularly comprehensive, and included (for

The Do 31E-1 was displayed in the static park at the 1967 Paris air show. Without the wingtip lift engines, a flying demonstration was not contemplated. The proposed production versions of the design, the Do 231C (civil) and M (military), would have been 23 m (75.5 ft) longer and 8 m (26.2 ft) greater in span and would have had no fewer than 12 RB.202 lift engines (eight in enlarged wing pods and two pairs in the fuselage).

example) model testing in the wind tunnels at VFW and at Fiat, and also at the AVA at Gottingen, the DVL at Cologne/Wahn, the DFL at Brunswick, the ARA (Aircraft Research Association) at Bedford, the NLR at Amsterdam, the Federal Aviation Works at Emmen (Switzerland) and the vertical spinning tunnel at Lille. Testing had to include every aspect of hovering and high-speed flight, ground suction, jet-induced drift and hot-gas re-ingestion in VTOL and STOL operations.

Perhaps more than any previous fixed-wing aircraft, the VAK 191B was all fuselage. The wings were deliberately made as small as possible in order to give the pilot a smoother ride in the all-important full-throttle mission at sea level. With a weight for vertical take-off that approached 17,625 lb (7995 kg) and gross wing area of 134.5 sq ft (12.5 m^2), the wing loading was always less than 131 lb/sq ft (640 kg/m^2), or significantly below that of the Lockheed F-104G and 104S which had no jet-lift capability.

Each wing was tapered at 48° on the leading edge, ending in a broad tip with a streamlined fairing housing the retracted outrigger landing gear. The leading edge was a fixed bonded light-alloy honeycomb structure. Similar construction was used for the conventional outboard powered ailerons and inboard plain flaps. The flaps were provided to increase deceleration in the landing transition and reduce landing speed in the CTOL mode. Each wing was attached to a fabricated box centre-section which had to be mounted high in order to be above the lift/cruise engine. Each wing was attached with sharp anhedral. Tail surfaces comprised a fin, powered rudder and powered slab tailplanes used for control in pitch only.

Engine starting

In the rear fuselage was the KHD T112 APU. This was considered essential to enable the aircraft to operate completely independently of ground facilities. The procedure was first to start the APU, by an electric starter fed from the 24-V batteries. This could then be used to check out all the onboard systems, including electronics cooling. When this had been done the lift/cruise engine would be started. Although the RB.193 was a turbofan similar to the Spey, with almost identical mass flow, it was a new design weighing much less (1,742 lb/790 kg). It could be started electrically or hydraulically, and all accessories were mounted on top where they were easily accessible through large doors in the top of the fuselage. To change the engine it was dropped out downwards through the weapons bay. The four nozzles were driven in unison by duplicate air motors and motor cycle-type chains, like those of Pegasus. The cruise setting was +6°30′ for the front (fan)

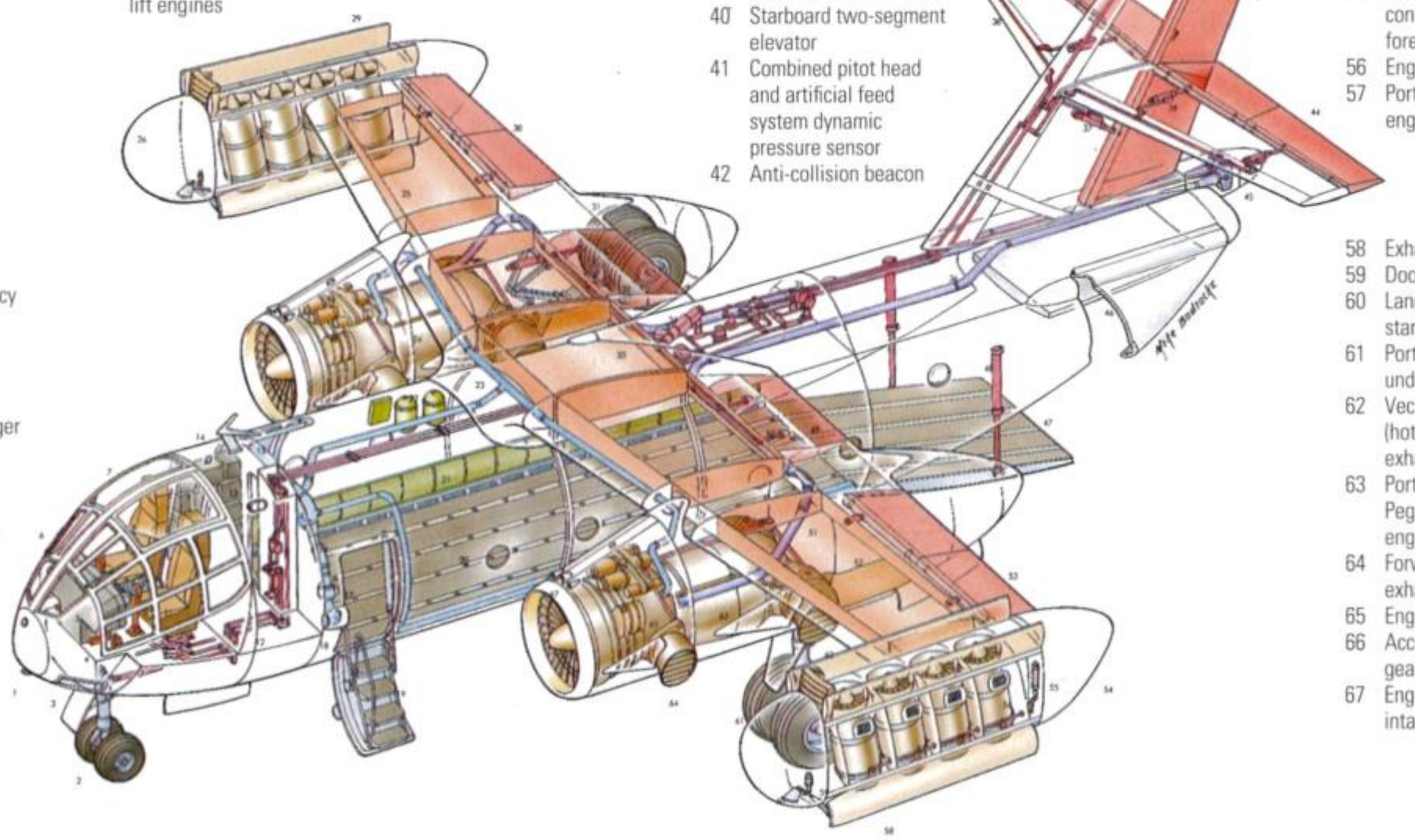
Specification

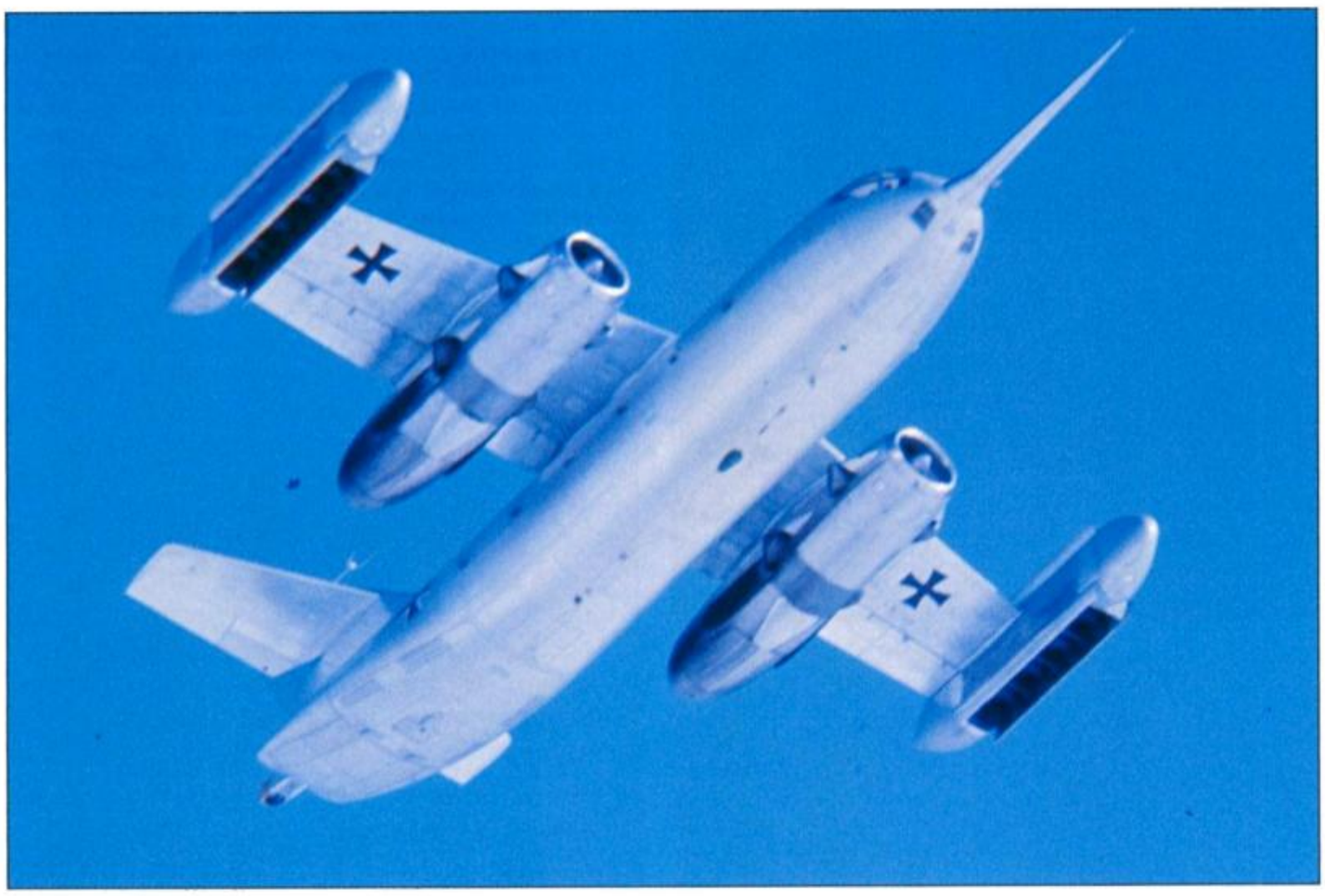
Do 31E-3

Type: experimental V/STOL transport aircraft
Powerplants: two Rolls-Royce Bristol Pegasus 5-2 vectored thrust turbofans each with 68.95 kN (15,500 lb) thrust in underwing nacelles, and eight Rolls-Royce RB.162-4D lift turbojets each with 19.57 kN (4,400 lb) thrust in wingtip pods
Performance: cruising speed at 6000 m (19,685 ft) 650 km/h (404 mph); rate of climb at sea level 1600 m (5,250 ft) per min; service ceiling 10500 m (34,500 ft)
Weights: maximum take-off 27500 kg (60,500 lb); payload 3000-5000 kg (6,600-11,000 lb)
Dimensions: span 18.06 m (59 ft 3 in); length 16.4 m (68 ft 6 in); height 8.53 m (28 ft 0 in); wing area 57.0 m^2 (613 sq ft)

Dornier Do 31E-3

1 ILS antenna
2 Twin-wheeled nose undercarriage
3 Downward vision window
4 Rudder pedals
5 Instrument console
6 Windscreen panels with wipers
7 Cockpit roof escape hatches
8 Co-pilot's ejection seat
9 Centre control pedestal
10 Control column
11 Pilot's ejection seat
12 Control rod runs and linkages
13 Cockpit doorway
14 VHF antenna
15 Starboard side emergency escape hatch
16 Cabin air system equipment
17 Main entry doorway
18 Air system heat exchanger air intake
19 Airstairs
20 Main cargo deck with roller conveyors and tie-down points
21 Troop seats (36), folded against cabin wall
22 Hydraulic system reservoirs
23 Cabin air system bleed air ducting
24 Starboard Rolls-Royce Bristol Pegasus 5-2 vectored thrust engine
25 Starboard wing integral fuel tankage
26 Wingtip lift engine pod
27 Rolls-Royce RB.162 direct lift engines
28 Hinged intake cascade
29 Intake doors
30 Starboard two-segment aileron
31 Main undercarriage, stowed position
32 Starboard flap
33 Wing centre-section fuel tankage
34 Flap control drive motor
35 Flight control system servo units and gearboxes
36 Reaction control bleed air ducting
37 Rudder hydraulic actuators
38 Fixed horizontal tailplane
39 Elevator hydraulic actuators
40 Starboard two-segment elevator
41 Combined pitot head and artificial feed system dynamic pressure sensor
42 Anti-collision beacon
43 Two-segment rudder
44 Two-segment port elevator
45 Pitch-control reaction air nozzles
46 Rear cargo bay doors
47 Cargo loading ramp
48 Ramp door hydraulic jacks
49 Port flap
50 Flap screw jacks
51 Engine bleed air ducting
52 Port wing integral fuel tankage
53 Port two-segment aileron
54 Port wingtip lift engine pod
55 Nozzle control jack, yaw-control, 7.5° movement fore and aft
56 Engine bay vent
57 Port RB.162 direct lift engines
58 Exhaust doors
59 Door actuator
60 Landing light, port and starboard
61 Port twin-wheeled main undercarriage
62 Vectored thrust engine rear (hot stream) swivelling exhaust nozzle
63 Port Rolls-Royce Bristol Pegasus 5-2 vectored thrust engine
64 Forward (fan air) swivelling exhaust nozzle
65 Engine oil tank
66 Accessory equipment gearbox
67 Engine bay venting air intake





This view of the Do 31E-3 beginning the transition to hovering flight shows the exhausts of the lift jets in the wingtip pods. Like all VTOL designs with separate lift and propulsive engines (in this case a total of 10 powerplants), the Do 31 suffered from excessive weight and complexity, and the problem of maintaining a stable hover in the event of one engine failing.

nozzles and +5°12′ for the rear (jet) nozzles. For VTOL the nozzles could quickly be rotated to 90°. For hovering the pilot could move the nozzle lever past a stop to a setting of 100°, when the horizontal thrust vector of the main engine cancelled out that due to the inclination of the two lift engines.

Once at the take-off point, the two lift jets could be started in a few seconds by using bleed air from the lift/cruise engine to impinge directly on the lift-jet turbines. Each lift jet was fixed, but was originally intended to be fitted with a fore/aft-deflecting nozzle ring. As installed, the inclination of these engines provided a modest propulsive thrust to assist take-off transition, and this could be enhanced by suitable deflection of the exit doors under the fuselage. These doors could also be used as airbrakes.

Three engines

All three engines were connected to the high-power bleed-air system needed for flight control in VTOL, when the airspeed was too low for aerodynamic controls to be effective. The largest ducts ran along each side of the fuselage and served twin pitch-control nozzles under the nose and twin pitch nozzles and two separate yaw nozzles under the tail. All were governed by rocking shutters driven by duplex hydraulic actuators with electrical signalling, and the nose and tail nozzles were interlinked by rotary torque shafts and intermediate gearboxes. Roll control was provided by three continuous-bleed pipes along the central part of each wing to one single and one twin reaction nozzle well inboard of the outrigger fairings. The roll nozzles could blast either up or down.

From a pilot's point of view, the Dornier was easy to fly – the control lightness needed for hovering gave 'fighter-like' handling at altitude. The E-3 was actually rolled at the 1968 Hanover air show. Manoeuvring in the hover was controlled by the stick, and climb and descent by the throttle. One of the few unconventional aspects of flying the Do 31 was the need to restart the lift engines during the approach.

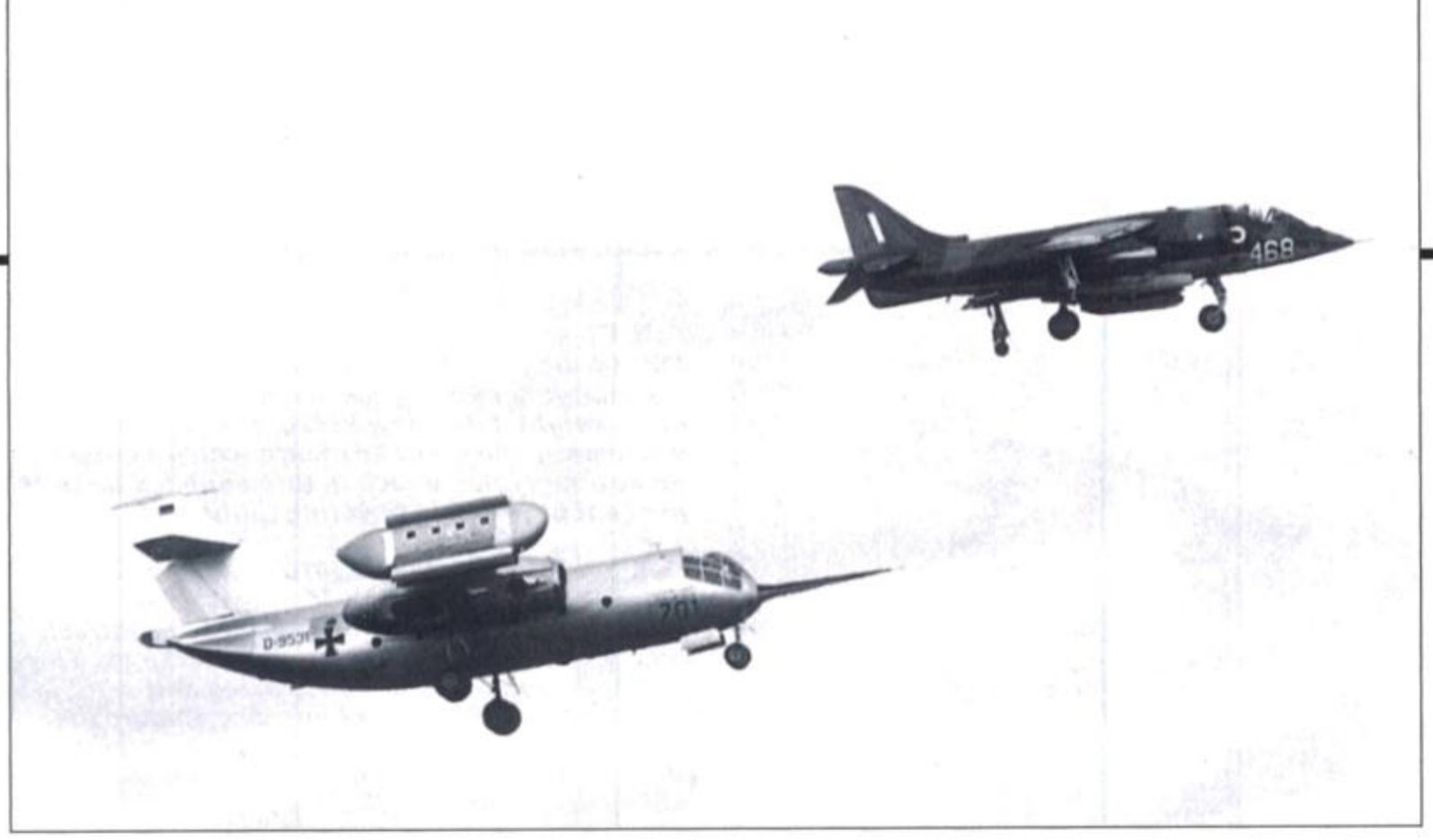
It was expected that a production aircraft would carry bombs or other weapons in the large internal bay, guns under the nose and missiles or other stores on six fuselage and four wing attachments. The flight-control system, however, was hardly expected to alter. For its day it was particularly advanced, with triply redundant fly-by-wire signalling, full power with autostabilisation on all axes with the possibility of manual reversion, with failure sources eliminated automatically. In the VTOL and hovering mode each position of the control column was associated with a particular autostabilised attitude, greatly easing the pilot's workload. For example, a 10° sideways displacement of the stick would at once roll the aircraft and then stabilise it in a bank of 10°. All controls were self-centring and self-monitoring, with pilot override possible in all circumstances.

By the time the VAK 191B prototypes took shape, the vital flight-control system had been virtually perfected, using simulators and the SG 1262 rig. Autostabilisation was normally operative throughout the flight envelope, but 180 kt (207 mph, 333 km/h) was established as the transition speed. Above this the aircraft behaved as a normal high-speed jet. Wing lift and control-surface reactions controlled flight in the normal way, so that stick positions commanded manoeuvre rates. Below this speed the bleed-air 'puffer jets' were operative, and stick position commanded an attitude. Thus, a sustained small lateral stick displacement would not cause the aircraft to roll slowly but merely adopt a slight wing-down tilt. Sudden application of full fore, aft or lateral stick deflection would cause the aircraft to pitch or roll 15°, at which its motion would be arrested.

The thrusts of the front and rear lift jets were continuously compared. Any sudden reduction in thrust of either engine resulted in immediate reduction in fuel flow to the other. Thus, should one engine fail, instead of the aircraft adopting a violent tumbling motion it would merely sink in a nearly level attitude, giving the pilot every chance of a successful ejection.

However, like so many aerospace programmes, while the engineers got it right, the politicians and programme managers could hardly have got everything more wrong. Even

German Jet VTOL



In the end, the German VTOL effort amounted to very little in practical terms. Problems of noise and fuel consumption, and the realisation that V/STOL transports needed airports nearly as large as conventional jets, led to the cancellation of the various projects. Nearly 30 years after this picture was taken, the Harrier remains the only truly successful fixed-wing V/STOL aircraft.

at the start, and influenced by the USAF, there were growing doubts about the need for VTOL. Instead of dispersing away from vulnerable airfields, discussions switched to the supposed penalties in cost, complexity and flight performance imposed by VTOL capability. From there on, things got steadily worse.

Strategy changes

Following interminable discussions in 1962-65, the NATO Military Committee decided to abandon its policy of 'massive (nuclear) retaliation' following the slightest breach of a notional 'tripwire' surrounding the NATO countries. Instead, a policy of 'graduated response' was adopted, and at a stroke this eliminated the low-level nuclear strike role. This removed the main purpose from the Luftwaffe's huge and troubled F-104G force, and also eliminated most of the need for a G91 replacement. Although nothing was announced, it was concluded that instead of being a 1,000-aircraft programme, the VAK 191B would not proceed beyond the prototypes.

In 1966 even this programme was under threat. It was first simplified by eliminating the two-seat version to leave six single-seaters, and later in that year it was cut in half and the last three examples were cancelled. By 1967 the Italians were becoming increasingly disenchanted with the whole concept, and, forgetting about the vulnerability of airfields, decided that the G91 replacement should be a twin-engined G91 called the G91Y. In 1968 they withdrew from the VAK 191B programme, leaving Fiat, Pirelli, Magnaghi and other firms as sub-contractors. Later in 1968, with the go-ahead of the British/German/Italian MRCA (Multi-Role Combat Aircraft), it was decided to continue the VAK 191B only as some kind of test vehicle in support of the MRCA.

Like EWR and Dornier, VFW/Fokker made use of a telescoping turntable to 'fly' the VAK 191B before actually letting it take to the air. The various intakes are covered to prevent foreign-object ingestion.

All this naturally resulted in a venture which might have been an important fast-moving programme at the so-called leading edge of technology changing into a sluggish diversion of valuable resources. Instead of starting flight testing in 1968, the first VAK 191B, bearing civil registration D-9563, did not even emerge from the Bremen factory until 24 April 1970. It then played on top of the telescopic pillar for over a year, and finally made its first free hover on 10 September 1971, a little over 10 years from the start of design.

The No. 2 aircraft first left the ground on 2 October 1971. It bore registration D-9564 and the bold logo 'VFW-Fokker' to proclaim the new company formed with the Dutch aircraft-maker on 1 January 1969. On 6 April 1972 it was stripped of various removable items and picked off Bremen airport by a Sikorsky CH-54B crane helicopter of the US Army which, with four intermediate stops, carried it 350 miles (563 km) to the Luftwaffe EK 61 test base at Manching which had been home to earlier V/STOLs.

Project wind-down

In August 1972, by which time all three aircraft were flying, a joint team from the US armed forces and NASA visited Bremen and Manching to see if they could find any new technology that might be useful. They found a programme ticking over with virtually no fresh funding. Predictably, the early estimates of cost had long since been exceeded, the original guess of DM227 million (£27.2 million), excluding the engines, having turned out in practice to be DM280 million (£36 million), to which had to be added DM230 million (£29.4 million) for propulsion. Today, even these figures appear remarkably modest.

The relaxed pace of development resulted in the first transition from a VTO to high-speed wingborne flight not being achieved until 26 October 1972. Good news from the VAK 191B camp was perhaps the last thing the Bonn government wanted, and just a month later the

Specification

VAK 191B

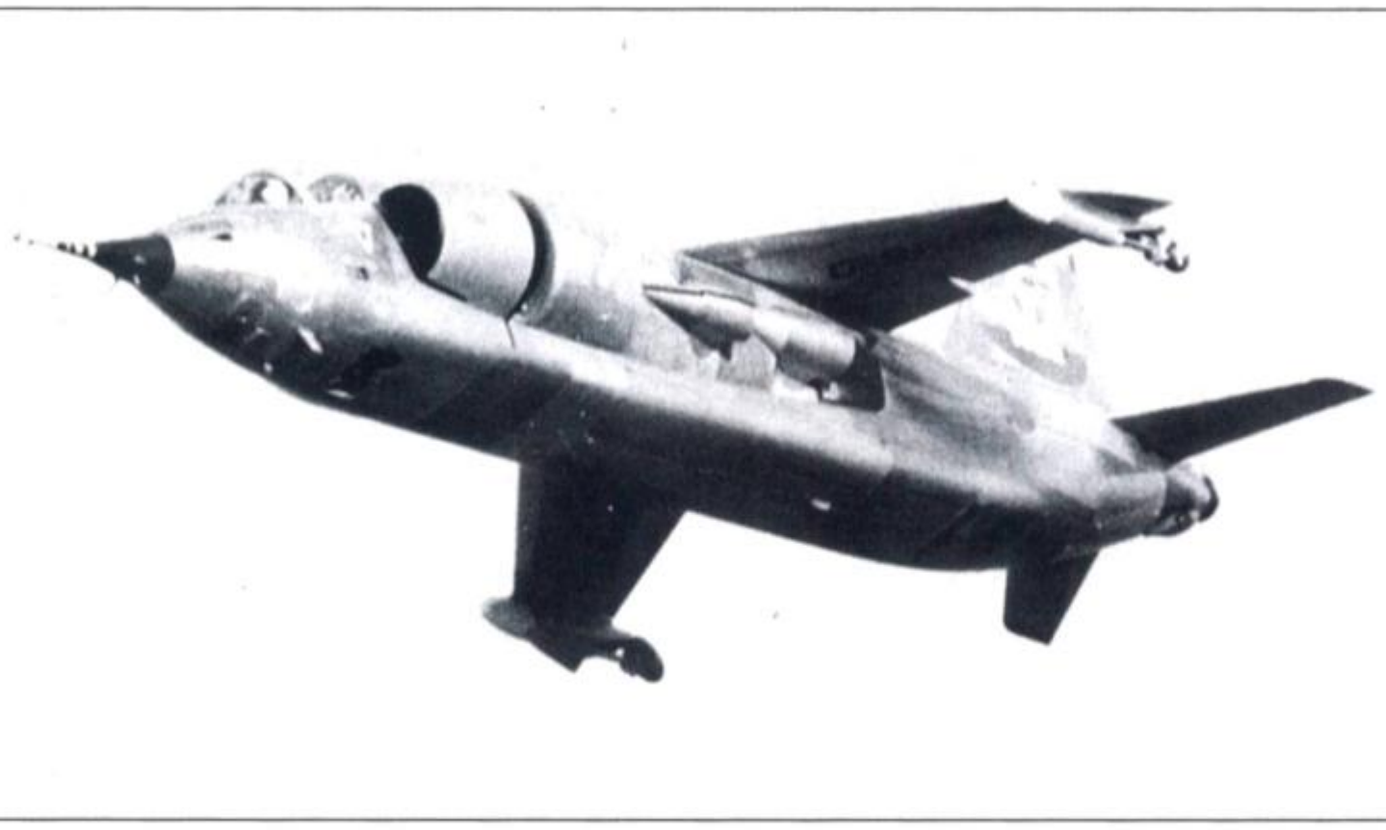
Type: single-seat VTOL tactical strike/reconnaissance aircraft

Powerplants: one Rolls-Royce/MTU RB.193-12 vectored thrust turbofan with 45.15 kN (10,150 lb) thrust and two Rolls-Royce RB.162-81 lift turbojets, each with 24.81 kN (5.577 lb) thrust

Performance: maximum speed Mach 0.96 at 300 m (984 ft), Mach 0.92 at 12000 m (39,370 ft); radius of action (lo-lo-lo) 370 km (230 miles)

Weight: maximum take-off 7500-9000 kg (16,535-19,840 lb)

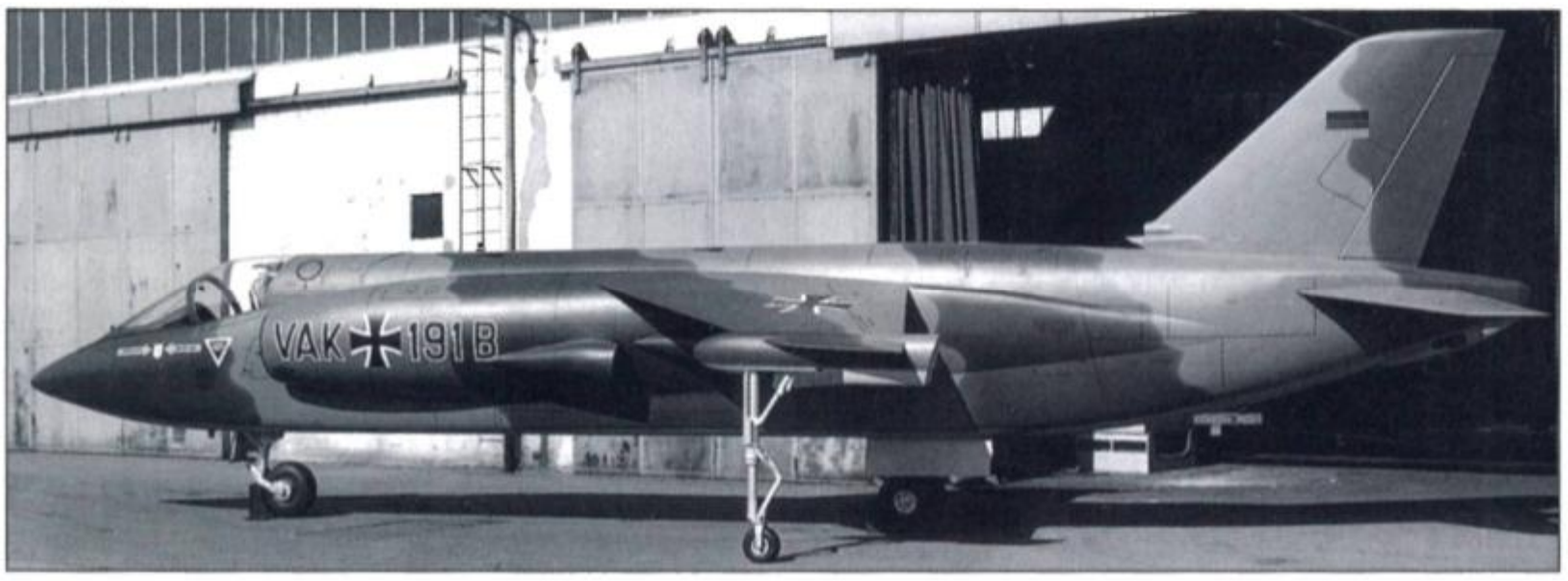
Dimensions: span 6.16 m (20 ft 2.5 in); length (with probe) 16.4 m (53 ft 7 in); length (without probe) 14.72 m (48 ft 3.5 in); height 4.30 m (14 ft 1 in); wing area 12 .50 m² (134.5 sq ft)

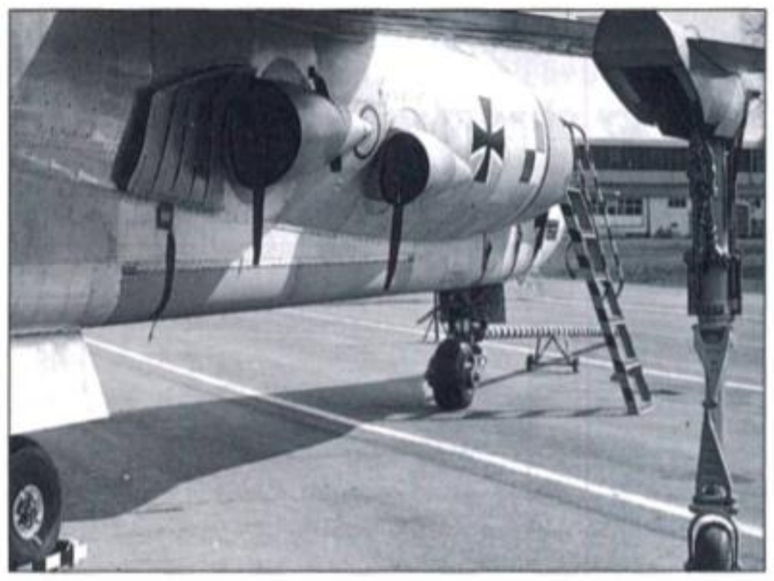


Left: Cleaned up and in horizontal flight, the VAK looked the part of a useful combat aircraft, but it was carrying two engines which were simply dead weight. Like the VJ 101C, the VAK 191B had a forward-sliding intake mouth which exposed an auxiliary inlet, which in turn supplied up to 80 per cent of thrust in hovering flight.

Below left: Unlike the VJ 101C, which was a pure research aircraft, the VAK 191B was intended to compete for the Fiat G.91 replacement contract, and was promoted in operational markings. This full scale mock-up was constructed and displayed in Luftwaffe colours, and (before the Italian government withdrew from the project) photographs of models in AMI colours were widely distributed.

Below: From this angle, the similarities between the VAK 191 and the Harrier are even more evident. Both aircraft featured bicycle main landing gear with outrigger supports and an almost identical overall configuration. This view shows the Pegasus-like vectoring nozzles but conceals the two additional lift engines.



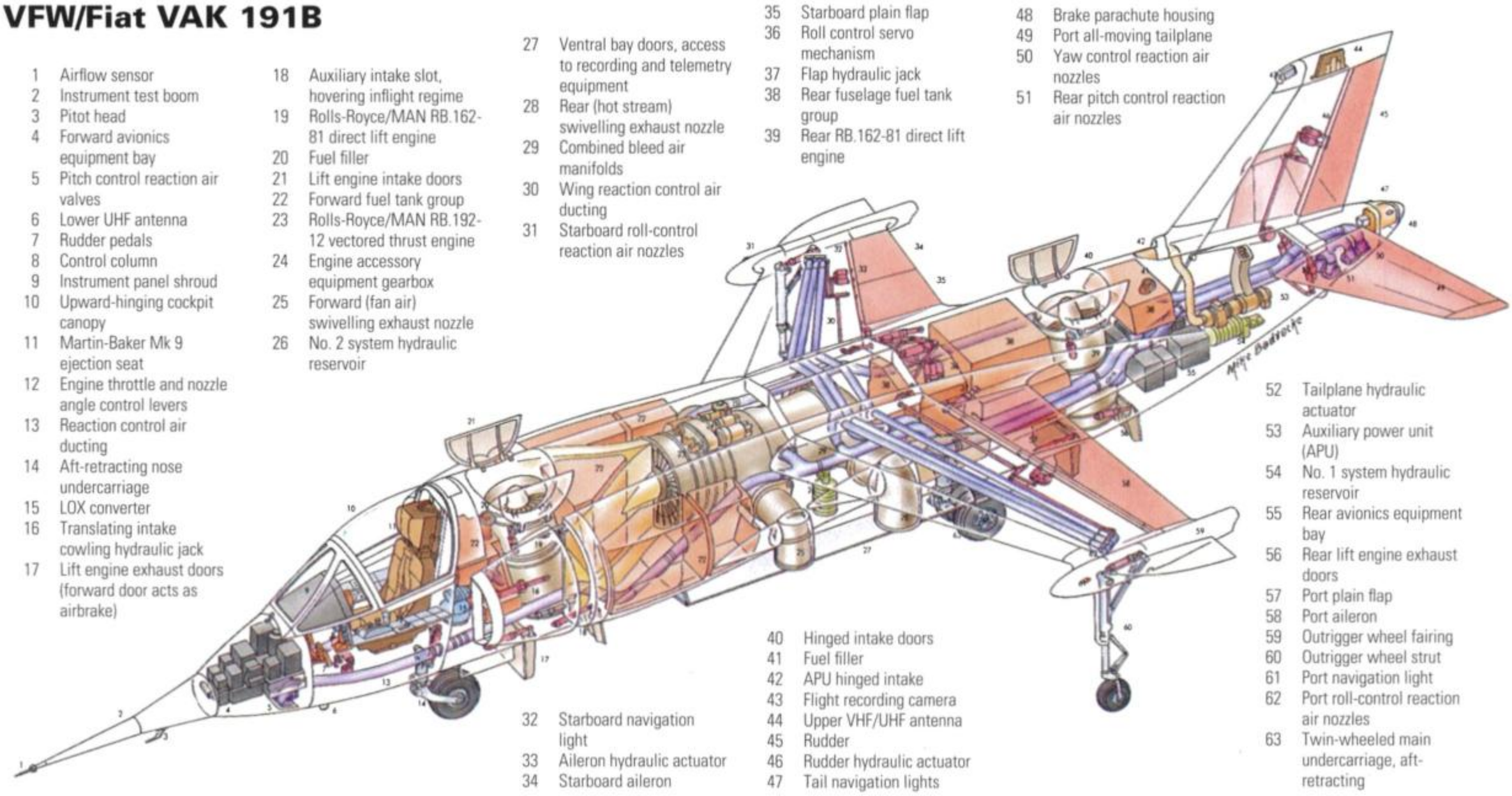


Ministry of Defence announced that at the end of 1972 all funding would cease. It stated that the jet-lift V/STOLs had been "based on a NATO doctrine which has now been abandoned." Nothing was said to explain why it had been abandoned.

VFW-Fokker had been one of the contenders in a US Navy competition to build an advanced V/STOL aircraft for the US Navy's Sea Control Ship, which was won by the complicated and unsuccessful Rockwell XFV-12A. The company had also sketched many next-generation V/STOL aircraft, including Mk 2 and Mk 3 derivatives of the VAK 191B with more powerful engines and

VFW/Fiat VAK 191B

1 Airflow sensor
2 Instrument test boom
3 Pitot head
4 Forward avionics equipment bay
5 Pitch control reaction air valves
6 Lower UHF antenna
7 Rudder pedals
8 Control column
9 Instrument panel shroud
10 Upward-hinging cockpit canopy
11 Martin-Baker Mk 9 ejection seat
12 Engine throttle and nozzle angle control levers
13 Reaction control air ducting
14 Aft-retracting nose undercarriage
15 LOX converter
16 Translating intake cowling hydraulic jack
17 Lift engine exhaust doors (forward door acts as airbrake)
18 Auxiliary intake slot, hovering inflight regime
19 Rolls-Royce/MAN RB.162-81 direct lift engine
20 Fuel filler
21 Lift engine intake doors
22 Forward fuel tank group
23 Rolls-Royce/MAN RB.192-12 vectored thrust engine
24 Engine accessory equipment gearbox
25 Forward (fan air) swivelling exhaust nozzle
26 No. 2 system hydraulic reservoir
27 Ventral bay doors, access to recording and telemetry equipment
28 Rear (hot stream) swivelling exhaust nozzle
29 Combined bleed air manifolds
30 Wing reaction control air ducting
31 Starboard roll-control reaction air nozzles
32 Starboard navigation light
33 Aileron hydraulic actuator
34 Starboard aileron
35 Starboard plain flap
36 Roll control servo mechanism
37 Flap hydraulic jack
38 Rear fuselage fuel tank group
39 Rear RB.162-81 direct lift engine
40 Hinged intake doors
41 Fuel filler
42 APU hinged intake
43 Flight recording camera
44 Upper VHF/UHF antenna
45 Rudder
46 Rudder hydraulic actuator
47 Tail navigation lights
48 Brake parachute housing
49 Port all-moving tailplane
50 Yaw control reaction air nozzles
51 Rear pitch control reaction air nozzles
52 Tailplane hydraulic actuator
53 Auxiliary power unit (APU)
54 No. 1 system hydraulic reservoir
55 Rear avionics equipment bay
56 Rear lift engine exhaust doors
57 Port plain flap
58 Port aileron
59 Outrigger wheel fairing
60 Outrigger wheel strut
61 Port navigation light
62 Port roll-control reaction air nozzles
63 Twin-wheeled main undercarriage, aft-retracting



The three VAK 191Bs are seen together in a rare photograph. The only significant visual difference between the three aircraft is a different nozzle configuration on the far (third prototype) machine. D-9563 (foreground) is preserved at the Deutsches Museum.

larger wings and, in the case of the Mk 3, supersonic performance.

Sadly, these proposals met with no favour, because by the 1970s aircraft able to disperse away from vulnerable airfields had gone out of fashion. Started with the highest of hopes, in an era when survivability in a real war was a matter of the most pressing concern, the VAK 191B suffered from many shortcomings. Among them were small overall size and power, inability to carry heavy loads of conventional weapons, poor STO performance, and a wing so small that (in the absence of effective inflight thrust-vectoring) combat manoeuvrability was inadequate.

US/FRG project

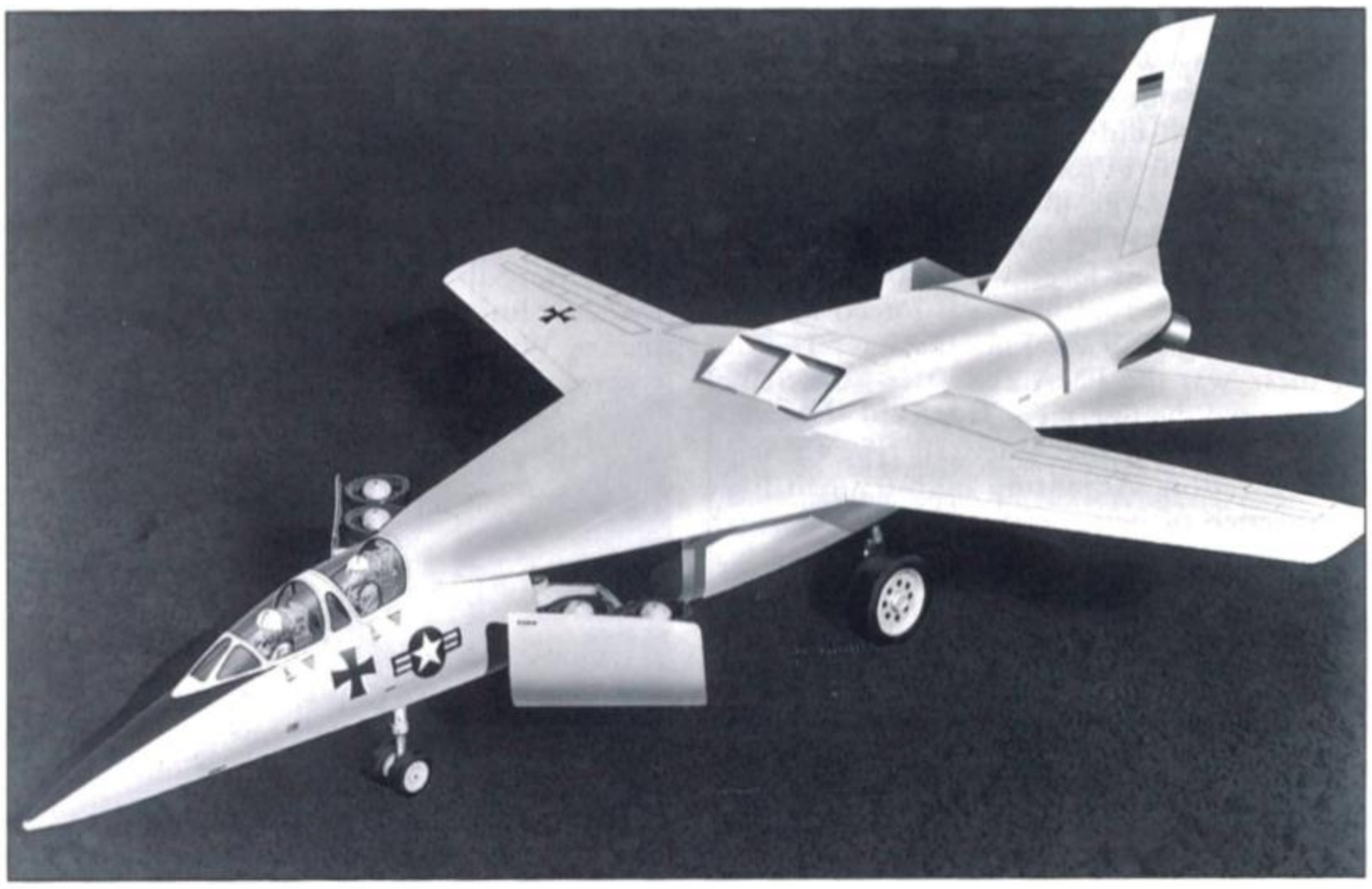
Also known as the AVS (Advanced Vertical Strike), this V/STOL warplane developed jointly by the US and the FRG (Federal Republic of Germany) was almost a lesson in how not to do it. By aiming to do everything, the result was an aircraft so complicated that it could hardly have been considered a practical proposition for front-line use in a real war.

In 1961 the most complicated submission in the NBMR-3 competition had been the D.24 Allianz (Alliance), a joint project by Republic Aviation of the USA and Fokker of the Netherlands. Among other features it combined a 27,000-lb (120.10-kN) thrust Bristol Siddeley BS.100 lift/cruise engine, separate lift engines and pivoted 'swing wings'. Of course, this competition led to nothing, but Republic had the bit between its teeth and was (perhaps rightly) convinced that jet-lift V/STOL was the way to go.

Republic (Fairchild Republic Co. from September 1965) continued to refine project studies. At the same time, about 30 Boeing engineers were working at EWR on a project called EWR 360. This was distinguished by pivoted 'swing wings'. This project was soon abandoned, and Boeing's place was taken by Fairchild Republic.

A key feature of the resulting AVS was use of the brilliant new lift jet specially designed for it. A joint project by Rolls-Royce and Allison, the XJ99 had two spools rotating in opposite directions; it was the first turbine not to need stator vanes, and had the world's shortest combustion chamber. The whole engine was only 41.8 in (1.06 m) long (or rather tall), and though it weighed only 440 lb (200 kg) it was rated at 9,000 lb (40.03 kN) thrust, an unprecedented 20:1 ratio.

The US/FRG project was launched in late 1966, concept definition took place from February 1967 and engineering design began in January 1968. Almost certainly wisely, the AVS was cancelled in April 1968. It was replaced by the NKF (Neue Kampfflugzeug), which in turn gave way to MRCA, which became the Tornado. Thus, a series of challenging VTOL programmes costing DM1.5 billion (£192 million) in the end came to nothing. **Bill Gunston**



Designed as a response to the Harrier, the EWR/Republic AVS (Advanced Vertical Strike, sometimes also called the US/FRG) aircraft was superficially a promising design, but never got beyond the model and artist's impression stage.

IAé Ñamcú

Argentinian Eaglet

The IAé.30 was an exceptionally clean and elegant aircraft, most closely resembling the de Havilland Hornet. Viewed from this angle it could be argued that the Namcú passed some of its genes to the FMA IA.58 Pucará of the 1970s.

Left: The one and only Ñamcú taxies across the central Argentine plains. This photo shows the split rudder and the undercarriage before fitting of the forward mainwheel doors, which are visible in later pictures.

Argentina's Ñamcú was one of the last piston-engined fighters to be built. Developed in haste, the Ñamcú showed great promise, but was doomed by the advent of jets and the peculiar politics of the period.

During World War II, Argentina was the only one of the Latin American nations which did not receive US lend/lease equipment, due in part to a perceived pro-Axis bias and the large number of German and Italian citizens in the country. In order to equip the Argentine air force with modern aircraft, the Instituto Aérotecnico was forced to adapt existing designs for local manufacture. The first of these was the FMA.21, a two-seat trainer which used the fuselage of a NA-16 -1P (NAA Yale) and shared the American type's general configuration. Argentine industry had little experience of work with light alloys, which were also in limited supply, so the type was developed into the IAé. 22, constructed primarily from wood. Two hundred of the Type 22 were delivered from 1943 with both US and British engines.

The series production of the IAé.22 led to the adaptation of another successful design by the Instituto Aeronáutico, the de Havilland Mosquito, which had the benefit of being designed *ab initio* for production in wood. Documents refer to the IAé.24 Calquin as 'inspired' by the Mosquito, but the similarity between the Calquin and the bomber version of the Mosquito was striking – apart from the obvious difference of the R-1830 radial engines fitted to the Argentinean aircraft. One hundred Calquins were built and they saw action in the 1955 coup which ousted President Péron.

After the war, with the German and Italian aircraft industries in tatters, many former Axis designers and engineers gravitated to Latin America, particularly Argentina. In November 1946 an Italian designer previously with Caproni, Ing. Cesare Pallavicino, who had moved to Argentina the previous summer, was appointed Chief Designer at the Instituto Aérotecnico in Cordoba and was entrusted with the development of a twin-engined escort fighter. Within a month he had submitted three tenders: two for jet designs, and one for a twin piston-engined propeller-driven aircraft. This latter design was chosen for development and the IAé established Special Design Division No. 2 to implement this programme, with a team of 16, later 20, including further former Caproni engineers.

Construction begins

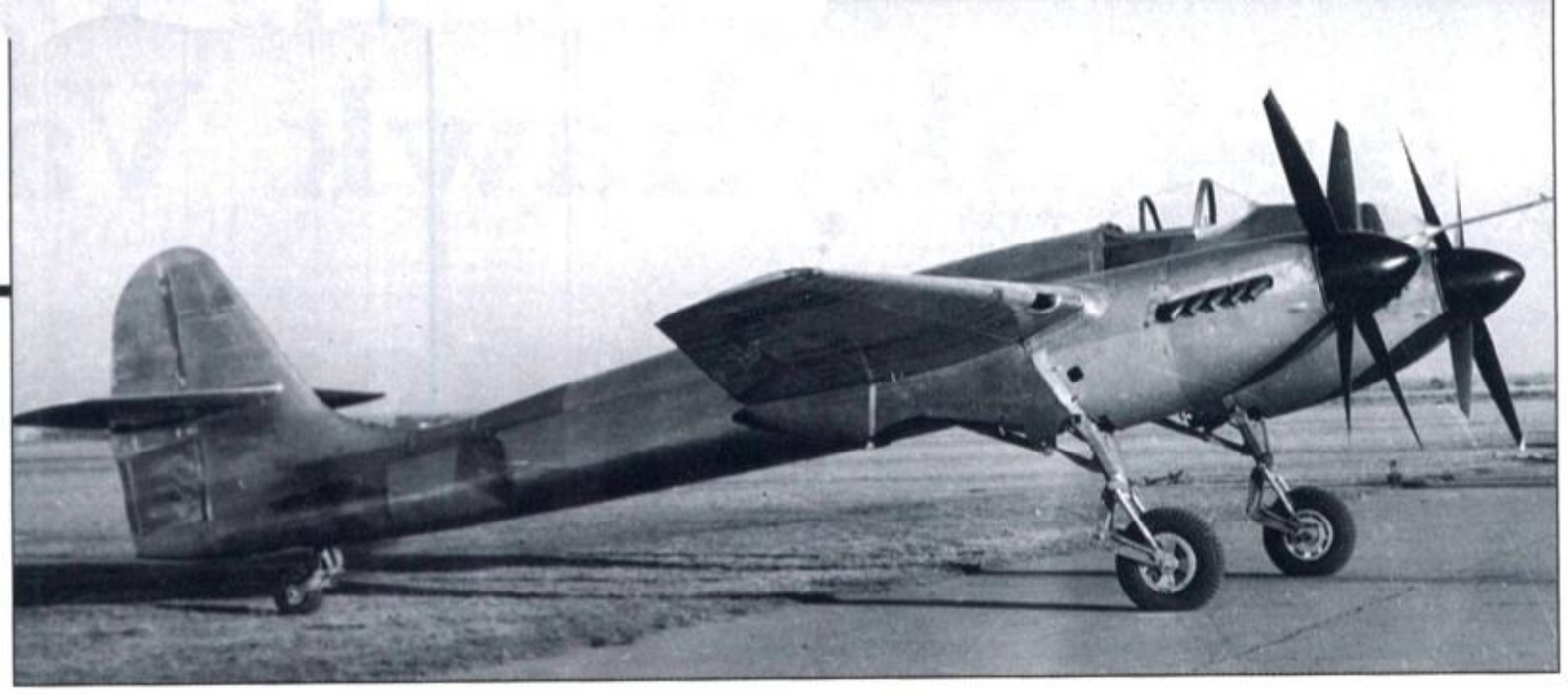
In July 1947 metal was cut, and the roll-out of the prototype occurred one year later. The resulting aircraft was an exceptionally clean all-metal mid-wing monoplane fitted with two closely-cowled 2,030-hp (1515-kW) Rolls-Royce Merlin 134/135 engines. Propellers were four-bladed de Havilland 4/4000/5 12-ft (3.66-m) diameter units. The aircraft was given the designation IAé.30 and the name Ñamcú, which means 'eaglet' in a Patagonian dialect.

The Ñamcú bore a striking resemblance to the de Havilland Hornet of 1944, although the Argentinean design was 13.5 in (34.3 cm) longer and 50.5 in (128.3 cm) greater in span. Given that the IAé.24 was based on the Mosquito, this similarity between the Ñamcú and Hornet was not surprising, although what was different was that the Ñamcú was of all-metal construction. The semi-monocoque fuselage was of roughly triangular or pear-shaped cross-section and was constructed in two parts, front and rear, with the join at the trailing edge of the wing. The broad lower fuselage allowed for the maximum armament to be included (six Hispano 804 20-mm cannon were proposed) with minimal frontal area. A transparent nosecone was fitted, pierced by a long pitot tube.

The wing was of cantilever type with two spars made in one piece tip-to-tip. High-lift split flaps were fitted, activated by a single hydraulic jack mounted in the fuselage. The ailerons, which were all-metal as were all the control surfaces, were constructed in three sections, possibly to counteract an expected tendency for the wing to flex. As with the Hornet, leading edge radiators were installed.

The undercarriage was of a relatively complex design, turning through 90° during retraction to lie flat at the rear of the engine nacelle. The main gear doors opened only during retraction and extension.

The completion of a prototype fighter within one year was an achievement beset by numerous difficulties, not the least of which was extreme pressure from the Argentine authorities to complete the aircraft. Consequently, static testing of the airframe was deferred until after the first flight, and in the end was never actually



The resemblance to the Hornet is most striking in this view of the Ñamcú at the time of its first flight. As well as receiving national insignia and undercarriage doors, the IAé.30 later gained a more heavily framed canopy and windscreen plus external aileron spring tabs.

carried out. The test flying programme began before the results of wind tunnel tests were available, increasing the risk in the programme.

In the last months of assembly, three work shifts were assigned to meet the deadline. A total of 70,000 man hours was spent on the design and drawing phase, with 370,000 man hours expended on construction.

The Ñamcú began taxiing trials on 8 June 1948 and, although construction had not been fully completed, the aircraft was ordered to be flown within 40 days. On 18 July 1948, First Lieutenant Guillermo Edmundo Oswald Weiss, the IAé's chief test pilot, took the Ñamcú into the air from Cordoba, its undercarriage locked down as the retraction mechanism was not yet installed. A short take-off was followed to a climb at half-power, turns, glides and a stall test – establishing the gear-down stall speed as 96.3 mph (155 km/h) IAS. The first flight lasted only 20 minutes, but was enthusiastically recorded in the local press – with no mention of the Italian contribution to the project. In the next fortnight, four or five more flights were carried out and the undercarriage retraction system was made operative. No particular handling or other vices were recorded.

On 8 August, First Lieutenant Weiss was ordered to take the Ñamcú from Cordoba to Buenos Aires, where it was to be demonstrated for the President. Weiss covered the 403-mile (648-km) distance in just 55 minutes, giving an average speed of 404 mph (650 km/h). The Ñamcú cruised at 18,370 ft (5600 m) using only half power, and with strong tail winds reached speeds as high as 485 mph (780 km/h) during the flight. The following day, the Ñamcú was demonstrated before President Péron, together with a Vickers Viking and the FMA Pulquí I jet fighter prototype. The President congratulated Pallavicino for his achievement and awarded him a medal for his invaluable contribution to the progress of Argentine aviation.

'Professor Matties', a.k.a former Focke-Wulf designer Kurt Tank, runs up the Ñamcú for one of its later test flights. Although Tank had no hand in the Ñamcú's initial design, it shared many common features with his own Fw 187.

Ambitious journey

The Ñamcú returned to Cordoba and the authorities began to plan a spectacular mission for it, a 13,670-mile (22000 km) round trip to the Farnborough air show, taking in Buenos Aires, Rio de Janeiro, Natal, Dakar, Canary Islands, Madrid, London, Paris and Rome. For the Atlantic crossing, auxiliary fuel tanks would have been fitted to extend the range beyond 3,100 miles (5000 km) and the Ñamcú would have been escorted by a pair of Lancastrians. Ing. Pallavicino strongly objected to this enterprise, since he felt the aircraft had not overcome its teething troubles and the pilot was not yet completely at ease with its handling. Given that this ambitious journey was planned to take place within two months of the maiden flight, and that the minimum of test flying had been undertaken, his concerns seem justified.

The Farnborough mission was cancelled, officially for 'financial reasons', but shortly after, in September, Pallavicino was removed from his post as chief designer and left with his 20 staff. The workshop and labour force switched to work on the Pulquí II prototype. Despite this, the government placed an order for 210 Ñamcús and Pallavicino was rehired to supervise their production and to fine-tune the prototype. At the end of October, Weiss flew the Ñamcú to La Paz in Bolivia where he demonstrated it at El Alto airport, and reached 560 mph (900 km/h) in a dive test.

Further test flying revealed that the Ñamcú's only faults concerned a control heaviness at high speed and insufficient aileron balance. Correcting these problems was a relatively simple matter, (spring tabs solved the aileron imbalance) but the work took an abnormally long time and was not completed until early April 1949. Communication between the design staff and the test pilots was poor and contributed to many misunderstandings and further delays, which in the long run prevented the machine from overcoming its last minor problems. The only reliable flight tests were those carried out by a Professor Matties – a pseudonym for Dipl. Ing. Kurt Tank himself, who at that time was designing the Pulquí II. Tank reported fairly favourably on the Ñamcú's flying performance and gave some useful advice on possible remedies for the few remaining problems. Late in April 1949 the Ñamcú order was cancelled. The official reason was once again 'financial reasons', and it is true that the second batch of 100 Calquins was cancelled at the same time. It seems more likely that the career of the Ñamcú, like the Hornet, was in fact terminated by the arrival of jet fighters of superior performance. Despite the government pressure on the design team to complete and demonstrate the prototype, an order for 100 Gloster Meteors had been signed just before construction of the Ñamcú began. The US was still reluctant to sell high-performance warplanes to Latin America, but the UK government was prepared to offer Meteors at a basic price of £32,000 each. Delivery was completed in September 1948, about the same time that official interest in the Ñamcú began to wane.

The fate of the sole Ñamcú is unknown, but is unlikely to have been as dramatic or farcical as that of the Calquin prototype, destroyed in a take-off collision with a train. Sir Stanley Hooker of Rolls-Royce, who was in Argentina attempting to sell Merlins and saw the Calquin crash, says that the wreckage was simply left on site and forgotten, which typified the *laissez faire* attitude prevalent in Argentina at the time. The Ñamcú may have been pushed to one side and left to corrode. This would have been a sad end to an elegant fighter, which, while derivative of another design, was potentially the ultimate piston-engined warplane.

Jim Winchester

Specification
IAé.30 Ñamcú

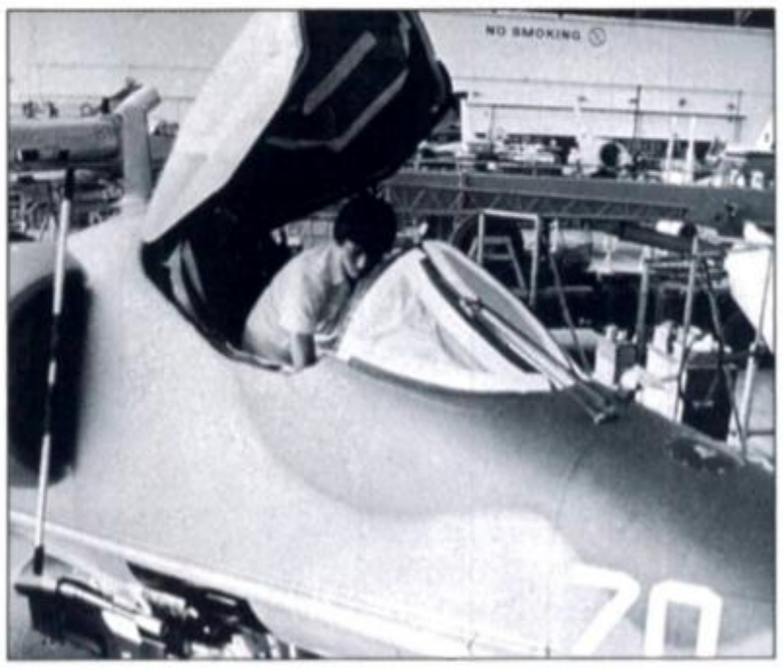
Powerplant: two Rolls-Royce Merlin 134/135 V-12 liquid-cooled engines, each of 2,035 hp (1517 kW)
Dimensions: length 37 ft 9½ in (11.52 m); wing span 49 ft 2½ in (15.0 m); height (in flying attitude) 16 ft 11 in (5.16 m); wing area (including fuselage) 380.19 sq ft (35.32 m²)
Weights: empty 12,312 lb (5585 kg); maximum take-off 19,300 llb (8755 kg)
Armament: (proposed) six Hispano-Suiza 804 20-mm cannon in nose, one external 250-kg bomb
Performance: cruise speed 311 mph (500 km/h); maximum speed 460 mph (740 km/h) at 21,000 ft (6400 m); climb to 16,400 ft (5000 m) in 5 minutes
Service ceiling: 26,250 ft (8000 m); range 1,680 miles 2700 km; endurance 5 hours 25 minutes

A-4 Skyhawk Variants Part 2: Export Versions

The Skyhawk may be approaching its half-century as a design, but the type is still an effective weapon. Most of the export users retain A-4s in their fleets and several are updating them to modern standards. This A-4K 'Squawk' of the RNZAF, seen here launching CVR-7 rockets over the White Island volcano, will be in service into the next millennium.

The Douglas Aircraft Company was prepared to offer the A-4 Skyhawk to other countries early in the production of the aircraft. However, this international marketing was subject to the wants and policies of the US Navy and, particularly, the US State Department. The sale of either new or used aircraft could be a benefit to the Navy because it reduced the cost of its Skyhawks and facilitated improvements to the basic airframe. However, Douglas was not given a blank check in its marketing efforts since the State Department did not want to upset the balance of power between countries that were on unfriendly terms. This was especially true in the Middle East and in South America. Negotiations on international sales between the various US and foreign governments and the Douglas Aircraft Company were sometimes long, and complicated by political considerations. As a result, some potential orders were lost to other overseas manufacturers not subject to the same restrictions that handicapped Douglas's marketing efforts. On example was Brazil, which wanted to buy 50 new A-4M aircraft in 1968; however, this order was held up in the State Department and Congress and, eventually, Brazil went to Dassault for Mirages. Colombia wanted to buy 18 A-4Ms but was not successful and also looked elsewhere for combat aircraft.

With a fine combat record in Vietnam and the Middle East, both as a carrier-based attack aircraft and as a land-based, close air support vehicle operating from forward airfields, the Skyhawk could offer an attractive option on the export market. As an example, US Department of Defense figures showed that the Skyhawk flew 60 per cent of the combat sorties of the US Navy and Marine Corps during 1965 in Vietnam. Under these gruelling conditions, their availability was between 85 and 95 per cent. They also demonstrated an amazing ruggedness and an ability to survive hits from enemy fire. In one instance, an A-4 was hit by four 37-mm cannon shells and was still able to return 230 miles (370 km) to its base. The Skyhawk proved to be a highly cost-effective weapon. For example, a new A-4F or a TA-4F could be made available for approximately $1 million depending on the numbers, timing, configuration and equipment, and could be delivered in less than two years to the customer. Equipped with five external store stations and multiple bomb racks, the Skyhawk could carry over 9,000 lb (4080 kg) of bombs, rockets, missiles, guns or other weapons. Effective



The Skyhawk has enabled several nations to develop their aerospace engineering industries. Singapore's A-4S aircraft have gone through a two-stage upgrade programme 'in country', including installation of a turbofan engine.

Malaysia's Skyhawks began life as A-4Cs for the US Navy, many later being rebuilt as A-4Ls for the Reserves. Before delivery they were rebuilt again as A-4PTMs (standing for Peculiar to Malaysia). The two-seat TA-4PTMs were also converted from single-seat A-4Cs and Ls.

combat ordnance loads could be delivered to a combat radius greater than 800 nm (1480 km). On shorter-range low-level strike and ground support missions a 5,000-lb (2268-kg) ordnance could be delivered to targets 100 miles (161 km) away utilising a 4,000-ft (1219-m) runway, and to 200 miles (322 km) from 6,000-ft (2440-m) runways.

Appealing features

The aircraft's flying qualities were superb and it featured excellent stability, control and manoeuvrability. The Skyhawk had the shortest turning radius in its class for its day and was designed aerodynamically and structurally to fly easily in the severe low-level environment at high subsonic or at low speeds while heavily loaded. Response to gust and turbulent air was such that, during the final attack run, the pilot could concentrate on weapons delivery with minimum attention to handling the aircraft.

In addition to its acknowledged prowess as an attack or close air support aircraft, the Skyhawk when fitted with two or four AIM-9 Sidewinder IR-guided air-to-air missiles could serve as an effective air defence fighter, especially under 20,000 ft (6096 m) where its high rate-of-role of 300 ° per second could not be topped. This feature also made it an excellent adversary trainer.

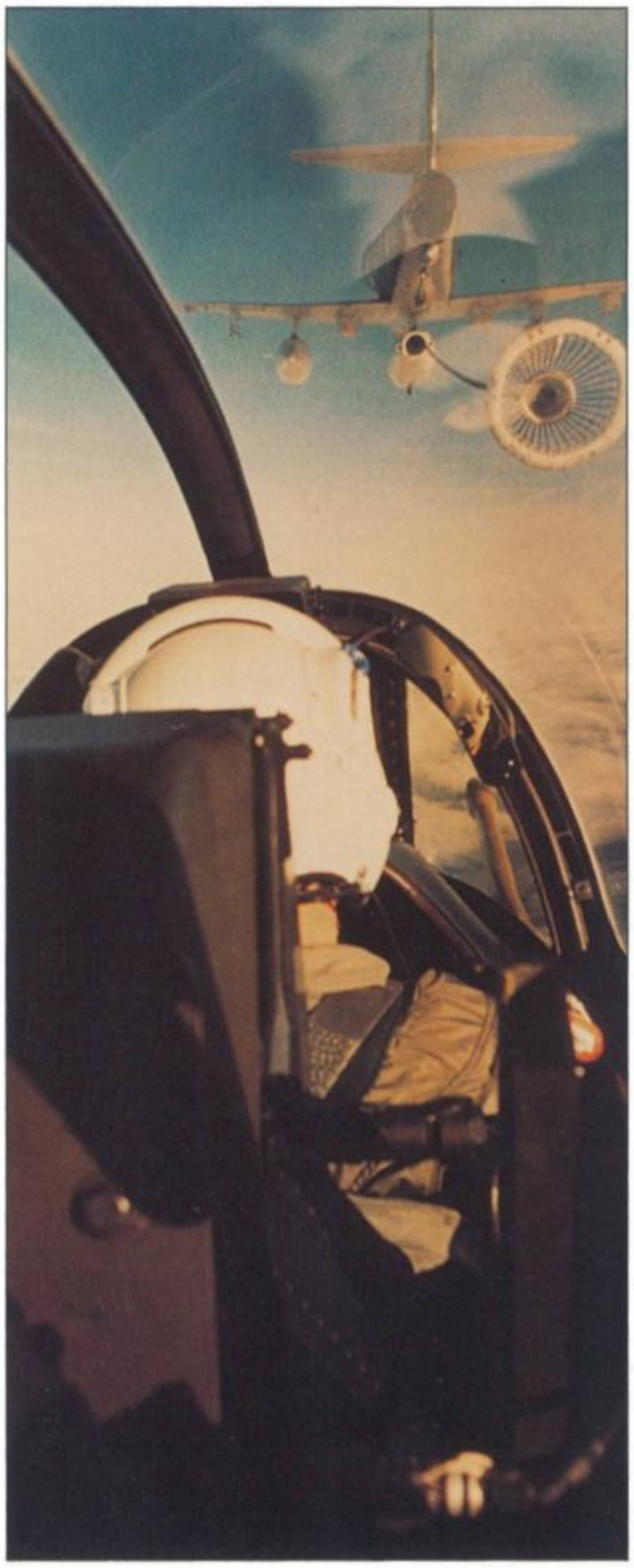
As early as 1958, Douglas prepared a specification for export customers on an aircraft based on the A4D-2 configuration and designated as DA-101. The US Navy was prepared to release A4D-2 aircraft that were relegated to surplus with the deliveries of new A4D-2Ns. The price of only $350,000 per aircraft made this version attractive to smaller countries. The offer of these aircraft was later tempered by the 1964 entry of the US into the Vietnam conflict, which dictated that some of the A4D-2s be called back into combat squadrons from the Reserves or from storage.

As the capabilities of the Skyhawk were expanded for the US Navy and Marine Corps, export versions offering some of these improvements were made available to other countries. To help identify some of these upgradings, Douglas introduced the designation of CA-4E and CA-4F for export versions that were essentially based on the A-4F airframe configuration. In the case of the two-place CA-4F, the 140 US gal (530 litres) of internal fuel that were removed from the fuselage to accommodate the second crewman could be replaced with an external tank that was located and smoothly faired on the upper fuselage aft of the canopy. This enclosure would have carried 210 US gal (795 litres) in a self-sealing tank. Although these versions were offered initially with the Pratt & Whitney J52-P8A axial-flow turbine engine developing 9,300 lb (41.37 kN) of thrust for take-off, other powerplants were considered as customer options. These included the Rolls-Royce RB 168 Spey rated at 12,000 lb (52.28 kN) of take-off thrust and the General Electric J79 (without afterburner) rated at 11,650 lb (51.82 kN) of take-off thrust. Both carrier- and land-based options were provided.

The CA-4F two-place Skyhawk was of fully ordnance-capable configuration. An advance-trainer, the CTA-4F, omitted portions of the combat equipment to provide an inexpensive, yet effective, advanced pilot trainer aircraft.

The development of the buddy system of inflight refuelling by the Douglas Aircraft Company also increased the A-4's export potential. The D-704 Buddy Store began as a separate project from the A-4 programme in 1955, and this system enabled the quick conversion of Skyhawks and other tactical aircraft into in-flight tankers. Unlike previous tanker kits, the Buddy Store, shaped like a high speed

Indonesia's Skyhawks have been involved in action against anti-government forces in East Timor for over 15 years and are not often photographed. In Indonesia, the A-4's roles include air strike, anti-shipping strike, reconnaissance and forward air control.



Above: With the Douglas-developed Buddy Store, A-4 users could refuel their aircraft in flight without the need to purchase a dedicated tanker aircraft. The 'cranked' refuelling probe was introduced to prevent intake fuel ingestion.

Above: The Royal Australian Navy was one of two export users to operate the Skyhawk from aircraft-carriers. A-4Gs flew from the single-catapult HMAS Melbourne *(ex-HMS* Majestic*) until 1982 and were the RAN's last ship-based fixed-wing fighters.*

Below: The Argentine navy still operates A-4Qs from its sole carrier, Veinticinco de Mayo*, which was commissioned as HMS* Venerable *in 1945. In the Falklands War, the naval Skyhawks operated from shore bases due to the perceived vulnerability of the carrier to British submarines.*

The Argentine air force flew its radarless, unsophisticated early model A-4s to great success in the 1982 Falklands War, sinking or contributing to the sinking of four British warships. The aircraft had been refurbished by Douglas at Tulsa, Oklahoma, where B-47s were also being built under licence to Boeing.

torpedo and carried on an external wing station, was self-sufficient and did not rely on a mother ship for primary power. The Buddy Store contained 300 US gal (1136 litres) of fuel, and the receiver could also draw on the tanker aircraft's internal fuel. With this feature, the tanker had many uses. It could allow the receiver to take off with a higher ordnance load and then top off its own fuel supply for a dash to the target. It could also extend the endurance of a tactical aircraft where necessary, such as when encountering a problem in the landing area or hitting a target at an extended range. One of the more important advantages

In Israeli service, the Skyhawk is known as the Ahit (Black Vulture). The first model purchased by the IDF/AF was the A-4H (reportedly, H stood for Hebrew), subsequently followed by A-4E, N and TA-4H variants. Despite a primary attack role, all export A-4s could carry a pair of AIM-9s.

of the Buddy Store was that a dedicated aircraft was not necessary, thus giving the battle commander much more flexibility in the use of his assets. Not only were the Buddy Stores used by the US Navy and Marine Corps, they were also used by the operators in Australia, Israel, Malaysia, New Zealand and Singapore.

Douglas offered a licensing programme under which the Skyhawk would be produced entirely in Europe or on a co-operative basis. Many countries indicated some interest in these export versions: France, Canada, Argentina and Australia looked at the Skyhawk for use on their carriers. Argentina and Australia were able to complete the negotiations. Many other countries were looking for aircraft to replace the F-84s or F-86s that equipped their post-war air forces. Countries that considered the A-4 as land-based replacements were Argentina, Belgium, Brazil, Chile, Colombia, Egypt, Greece, Indonesia, Israel, Lebanon, Malaysia, Netherlands, New Zealand, Peru, Philippines, Singapore, Spain, Switzerland, Tunisia and Zaïre. Those countries that eventually chose the Skyhawks were Argentina, Australia, Indonesia, Israel, Kuwait, Malaysia, New Zealand and Singapore.

Since all contracts for A-4 production were monitored by the US Navy Bureau of Weapons (BuWeps), all that were built were assigned a US Navy bureau number (BuNo.) for accountability regardless of the eventual customer. In some cases, these BuNos were incorporated with the serial number of the customer and are listed here to ease the identification of specific models. **Harry S. Gann**

Left: Although the A-4 has now largely been replaced by the F-16, the Israeli air force remains the largest foreign user of the type. A-4s, such as these Ns seen here, formed the bulk of the Israeli attack force in some of its toughest actions.

Below left: Kuwait's A-4s saw action in 1990/91, against Iraqi forces, just before they were due for replacement by F/A-18 Hornets. During the war, they flew over 1,350 sorties for only one loss.

Below: By the time some A-4 users retire their aircraft, the airframes may be 50 years old (albeit rebuilt once or twice). The slogan on crew-room walls, bumper stickers and patches around the world says it all.

A-4 Skyhawk export variants

Argentina (A-4C, A-4P, A-4Q, A-4M, OA-4M)

In 1965, the Argentine air force negotiated an order for 50 of the redundant US A4D-2s to replace its Gloster Meteor and North American F-86 aircraft. These aircraft were to be withdrawn from storage and refurbished by the Douglas Aircraft Company at its Tulsa, Oklahoma facility. Later, they were redesignated as A-4P Skyhawks although the users appeared to prefer the A-4B designation. The first 25 were delivered from 1966 while the second group was deferred until 1970. This delay was caused by a US Congressional complaint that the US Naval and Marine Reserve forces would be forced to use "substantially inferior" A4D-1 versions. In 1975, an additional 25 A4D-2N (A-4C)s were procured, again from surplus stocks. These aircraft were updated by the Lockheed Air Services, located at Ontario, California. The Argentine navy also purchased 16 A4D-2s in 1971 which were redesignated A-4Q, and which were altered by Douglas Aircraft Company. In 1995, 36 A-4M and five OA-4M aircraft surplus to US requirements were allocated to Argentine air force.

The initial Skyhawks delivered by Douglas to Argentina were powered by the Wright J65-W-16A giving 7,700 lb (34.25 kN) of thrust (A-4P) and the J65-W-20 with 8,400 lb (37.37 kN) (A-4Q). Both were outfitted with the Escapac 1 ejection seat with the Stencil modification, and were equipped with the lift spoilers installed on the A-4F and later Skyhawks. Neither was equipped for loft bombing. The A-4P was not equipped with the Sidewinder installation, but the A-4Q was wired to fire the heat-seeking missile. Both retained the standard 20-mm cannons with 100 rounds for each gun.

Those Skyhawks used by the Fuerza Aérea were delivered to V Brigada Aérea and assigned to Grupo 5 de Caza 'Halcones' in October 1966, where they were operated by I and II Escuadrones. The A-4Cs delivered in 1975 were assigned to Grupo 4 de Caza of the IV Brigada Aérea, forming I Escuadron. With the outbreak of the Falklands War in 1982, it appeared that about 30 of the original 50 A-4Bs and 19 of the 25 A-4Cs were still operable; however, a shortage of spare parts had made the full use of these aircraft suspect. Nineteen Skyhawks were subsequently lost by the Argentine air force during the war: 10 A-4Ps and nine A-4Cs.

The Commando de Aviacion Naval Argentina (CANA) operated the A-4Qs aboard its carrier *Veinticinco de Mayo* and were assigned to 2 Escuadrilla de Caza Y Ataque, a component of 3 Escuadra Aéronaval. Later, that squadron was redesignated as 3 Escuadrilla. The Argentine navy lost six Skyhawks in the war with England.

To replace its war losses, Argentina negotiated in February 1994 with the US Navy and was able to obtain sufficient surplus aircraft to make 36 operable A-4M Skyhawk IIs. Lockheed Aircraft Services was chosen to refurbish and tailor the aircraft to the specific requirements of the Fuerza Aérea. This included depot-level inspections and rewiring, engine refurbishment, avionics upgrade, pilot and mechanics training, spares provisioning and technical documentation. The avionics upgrade would consist of a Northrop Grumman AN/APG-66 multi-mode radar, a navigation-attack system, Sextant Smart HUD, and liquid-crystal displays, an INS and and on-board computer mission planning system. Also included in the upgrade will be HOTAS (Hands On Throttle And Stick) and OBOGS (On-board Oxygen Generating System). Notably deleted from the aircraft was the Hughes Angle Rate Bombing System (ARBS), which were returned to the supply system for use in the AV-8B Harrier of the USMC. The delivery, scheduled to begin in 1997, will supplement the remaining 29 A-4P Skyhawks that are still in Argentine service.

The first A-4M for the Argentine programme was flown from the storage base at Davis-Monthan AFB, Arizona to the Lockheed Martin Air Services facility at Ontario, California on 1 August 1995, followed by a second aerial delivery three days later. They were marked respectively as C-906 and C-905. The balance of the aircraft were trucked in. It was expected that the 36 aircraft would be refurbished over a three-year programme, with the first 18 to be overhauled and modified at Ontario and the balance to be serviced by Lockheed Martin Services International in Cordoba, Argentina. The OA-4Ms involved may be destined for spares retrieval, as the Argentine forces have not previously operated two-seaters.

Above: C-207 was an A-4P from the first batch delivered to the Argentine air force. It is seen here at an exhibition in Buenos Aires soon after delivery in a natural metal colour scheme. On 25 May 1982, C-207 sank HMS Coventry off West Falkland Island.

Right: An A-4P photographed after the Falklands War shows the spoilers fitted to this and other export versions of the A-4B and C. Also visible is the large ADF aerial blister on the fuselage and 'ring'-type fin aerial.

The Argentine navy's A-4Qs were externally the same as the air force's A-4B/Ps. They were refurbished by Douglas at Tulsa, Oklahoma, where 3-A-215 is seen prior to its delivery.

Argentine Air Force (Fuerza Aérea Argentina) A-4P (A-4B) Caza (Hunter) Numbers
(In addition, it is known that BuNos 144894, 144932, 145017, and 145053 were cannibalised for spares.)

Number	BuNo.	Number	BuNo.
C-201	142799	C-212	142773
C-202	142171	C-213	142129
C-203	142421	C-214	142109
C-204	142136	C-215	142102
C-205	142694	C-216	142098
C-206	142762	C-217	142747
C-207	142688	C-218	142099
C-208	142139	C-219	142416
C-209	142684	C-220	142796
C-210	142128	C-221	142108
C-211	142701	C-222	142752
C-223	142110	C-237	142788
C-224	142110	C-238	142830
C-225	142803	C-239	142838
C-226	142090	C-240	142855
C-227	142104	C-241	142859
C-228	142728	C-242	142862
C-229	142734	C-243	142866
C-230	142736	C-244	142883
C-231	142748	C-245	142893
C-232	142749	C-246	142901
C-233	142757	C-247	142902
C-234	142760	C-248	142910
C-235	142765	C-249	142911
C-236	142784	C-250	142914

Since the war, the different versions of the Skyhawk in the Argentine air force have operated together in the same units. The leading aircraft of this V Brigada Aérea formation is an A-4C, and the other is an A-4P.

Argentine Air Force (Fuerza Area Argentina) A4D-2N Caza (Hunter) Aircraft

Number	BuNo.	Number	BuNo.
C-301	147714	C-313	150595
C-302	148438	C-314	149564
C-303	149526	C-315	148531
C-304	149618	C-316	147806
C-305	148562	C-317	147830
C-306	148435	C-318	148556
C-307	148452	C-319	148533
C-308	148612	C-320	149642
C-309	147747	C-321	147741
C-310	148450	C-322	149514
C-311	148517	C-323	148467
C-312	147765	C-324	148559
		C-325	149585

Argentine Navy (Commando Aviacion Naval Argentina - CANA) A-4Q Aircraft

CANA assigned its numbers 0654 through 0669 to the 16 A-4Q aircraft. These numbers were painted on the vertical stabiliser. In addition, radio callsigns of 3-A-301 through 3-A-314 were painted on both sides of the mid-fuselage. There is no explanation as to the assigning of only 14 side numbers for the 16 aircraft.
The 16 Bureau Numbers of A-4Bs delivered to the Argentine navy are:
144872, 144882, 144895, 144915, 144929, 144963, 144983, 144988, 144989, 145001, 145004, 145010, 1450125, 145050, 145030, 145061.

The following A-4M and OA-4M aircraft have been sold to Argentina (an unknown number of which will be used for spares recovery):

A-4M (36): 158161,158165,158167,158171 158417,158419,158423,158426,158428, 158178,158193,158413,158414.158429,159470, 159471,159472,159473,159475,159478,159483, 159486,159487,159493,159778,159780,159783, 160025,160029,160032,160035,160039,160040 160042,160043,160045

OA-4M (5): 153531,154294,154328, 154645,154651

The first two A-4Ms for Argentina flew in to Ontario airport in August 1995. It is reported that they will be designated A-4AR Fightinghawk when they enter service with two as yet unknown units from 1997.

An additional four aircraft (A-4Ms 158170, 158184 and OA-4Ms 152874 and 154306) are still stored at AMARC but earmarked for Argentina.

Australia (A-4G, TA-4G)

The procurement of Skyhawks for the Royal Australian Navy was driven by the role of its aircraft-carrier, HMAS *Melbourne,* which was to combat an apparent threat that existed from Indonesia during the 1960s. This – coupled with the end of the service life of the Fairey Gannet and de Havilland Sea Venom fixed-wing, strike aircraft – brought about a requirement for a replacement aircraft that could operate from the short deck length (700 ft/213 m) and limited catapult capability of that carrier. The A-4 was the only aircraft considered for that role by the RAN and was the first new production Skyhawk aircraft to be exported.

The *Melbourne* had been originally laid down in Great Britain in 1943 as the HMS *Majestic* and was launched in 1945. Acquired by the RAN in 1955, it was refitted with an angled deck, steam catapult and mirror deck landing systems.

On 26 October 1965 the Royal Australian Navy announced that it would procure 10 Skyhawks for operations aboard the *Melbourne*. The Minister of the Navy stated that they would "provide the carrier with a proven counter against hostile reconnaissance aircraft and with a limited strike capability against surface force attacks in convoy operation. Their acquisition would round out the carrier's capabilities and increase further its anti-submarine capability." Authority to proceed was given to Douglas Aircraft Company on 15 April 1966 and the A-4G was first flown on 19 July 1967 by test pilot Jim Stegman. He also made the first flight of the TA-4G on 21 July 1967.

The first two aircraft, an A-4G and a TA-4G, were turned over to the RAN on 26 July 1967 in a ceremony at the Douglas Aircraft Company plant in Long Beach, California. The balance of the order was delivered to the Naval Air Station at North Island, California to be stored awaiting the arrival of the *Melbourne* for transportation back to Australia in a single trip. During this period of storage, RAN pilots were in training at NAS Lemoore, California in American Skyhawks to become proficient in the operational characteristics of the A-4s and to provide a cadre of instructors. In 1970, another 10 aircraft (eight A-4Gs and two TA-4Gs) were obtained from US Navy fleet stock and were reconfigured from existing A-4Fs and TA-4Fs.

Operationally, the Australian Skyhawks were assigned to two Fleet Air Arm Squadrons. 805 Squadron (later VF-805) was the primary combat user and flew from the carrier or, if shore-based, from Nowra. 724 Squadron (later VC-724) was the A-4 Operational Flying Training School and was also based at Nowra. When the *Melbourne*'s operations were ended in 1982, the balance of VF-805's aircraft went to VC-724, which used them mainly for target towing. Ten A-4s survived their service life with the RAN and were sold to the Royal New Zealand Air Force in 1984, reconfigured and redesignated as A-4K to supplement the fleet of New Zealand Skyhawks. In 1990 an agreement was reached between Australia and the RNZAF for the New Zealanders to station and operate four A-4Ks and two TA-4Ks at Nowra in support of Australian defence, thus bringing the Skyhawks back to familiar grounds. This posting also offered the advantage of adversary training with dissimilar aircraft for New Zealand pilots.

The A-4G was a tailored version of the A-4F optimised for the air defence role, and could mount Sidewinder heat-seeking missiles on the four underwing stations. (The centreline station was not used for this purpose.) They retained a limited attack capability but were not equipped to launch nuclear weapons. The two 20-mm guns each with 100 rounds of ammunition were fitted. The aircraft were powered with 9,300-lb (41.37-kN) thrust Pratt & Whitney J52-P8A axial flow turbine engines and were fitted with nosewheel steering, wing-lift spoilers, and Escapac 1C-3 zero-zero emergency ejection seat of the A-4F configuration. Although they had provisions installed, they were not equipped with the aft avionics package. The aircraft could be equipped with an inflight-refuelling external store (buddy tank) or could take on fuel

Above: The A-4G was basically an A-4F without a hump and was operated from HMAS* Melbourne *from 1969 until 1982. The A-4Gs suffered a high attrition rate in service. This view of an VF-805 (805 Sqn) A-4G dates from 1972.

Because of the different centre-of-gravity of the TA-4G, the two-seater could not operate from the short deck of* Melbourne. *They were assigned to the shore-based training unit VC-724 at Nowra, the squadron designation reflecting a change to US procedures in 1969.

The Australian navy operated the A-4G as a fighter, equipped with four AIM-9s, but the type also had a secondary ground-attack role. This A-4G is seen firing 2.75-in (7-cm) FFAR rockets.

A-4 Export Variants

from a hose-and-drogue system. Without the use of inflight refuelling, the A-4 could still accomplish a ferry flight of 2,050 nm (3797 km) with internal fuel of 800 US gal (3028 litres) and three external tanks of 1,000 US gal (3784 litres). This included a 10 per cent landing fuel reserve. With one 300-US gal (1136-litre) centreline tank and 12 bombs weighing 250 lb (113 kg) each mounted on multiple bomb racks, the A-4G could go out 700 nm (1296 km), deliver the ordnance in a close air support mission and return. In its air defence mission, the A-4G could carry two Sidewinder air-to-air missiles and two 300-US gal external fuel tanks, and stay on station for three hours at a combat radius of 250 nm (463 km).

Although the TA-4G was based on the TA-4F configuration, it could not safely operate from the relatively short deck of the *Melbourne* due to the aircraft's forward centre of gravity condition, which restricted deck take-off in the case of a 'bolter' (when the arresting cables are missed and the aircraft must take off in the remaining distance). However, the TA-4G was an excellent trainer as it retained all of the ordnance-launching capabilities of the single-place A-4G.

US Navy/RAN serial numbers

A-4G

Amt	RAN No.	Serial Numbers
8	882 to 889	N13-154903 to 154910
2	870 to 871	N13-155051 to 155052
1	872	N13-155055
5	873 to 877	N13-155060 to 155064

TA-4G

Amt	RAN No.	Serial Numbers
2	878 to 879	N13-154647 to 154648
2	880 to 881	N13-154911 to 154912

In 1984, the surviving A-4Gs were sold to the Royal New Zealand Air Force, and later updated with new radar and modern avionics. For a time, the aircraft wore their final RAN colours with RNZAF markings. NZ 6217 was previously N13-155062.

Israel (A-4E, A-4H, TA-4H, A-4N)

To replace aircraft lost in the Yom Kippur War,the United States sent a number of A-4Es to Israel directly from USN stocks, flown from an aircraft-carrier in the Mediterranean. This is BuNo. 150091 just after arrival in Israel.

As early as 1963, Douglas marketing personnel had talked to the Israeli Defence Forces regarding their possible use of the Skyhawks in their conflicts with their neighbouring countries. Various options were discussed which included surplus stock from the US Navy inventory as well as new aircraft. These negotiations were tempered by the neutrality policies of the US government that were in effect at that time, aiming to maintain the friendship of the Middle Eastern countries that surrounded Israel and at the same time counter any intrusions of the Communist influence. In addition, there was considerable pressure not to disturb the flow of relatively cheap petroleum from Israel's enemies that satisfied the demands of the American automobile-owning public. In 1966, the American government allowed the approval of a request to obtain Skyhawks made by the Israeli government in 1964. This move was made to redress to some extent the sale of late model American, British and Russian aircraft to Israel's Arab neighbours; this included Lockheed F-104s to Jordan, English Electric Lightning fighters to Saudi Arabia and Russian MiG-21s to the United Arab Republic and Syria.

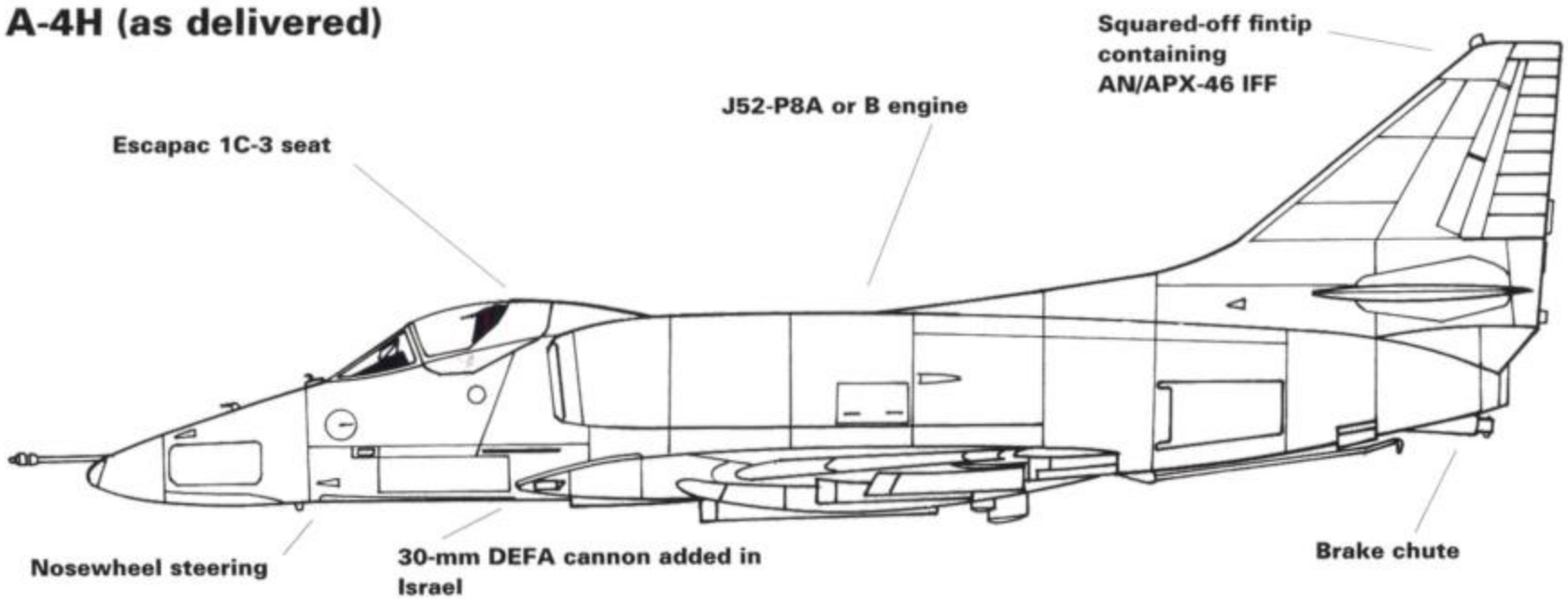
A contract was initiated in August 1966 for 48 aircraft to be designated as A-4H Skyhawks. The agreement stated that these modified A-4F aircraft were to be for 'Stockpile Z utilisation', a code phrase that must have caused more speculation than concealment. First flight of this version was made at the Douglas facility at Palmdale, California on 27 October 1967 and was undertaken by test pilot John Lane. Four A-4Hs arrived by ship in Israel in December. By April 1968, Israeli Skyhawks were attacking targets in Jordan. The order was further increased to a total of 90 aircraft while deliveries continued through 1970. To supplement the single-place Skyhawks, 25 TA-4H two-place aircraft were also delivered from 1969 through 1975 (first flight 15 April 1969 by John Lane). These trainers were variants of the TA-4J and in some instances were referred to as TA-4(J)H. The A-4H differed from the US A-4F in the deletion of the aft avionics package, a squared-off vertical fin caused by the addition of the AN/APX-46 radar identification (IFF) antenna, and the inclusion of a drag chute under the aft fuselage to reduce landing roll-out and to extend the life of the brakes and tyres.

In service, Israeli A-4Es were fitted with locally-designed equipment to provide better combat survivability. This 116 Sqn A-4E, seen in 1970, is still basically a stock aircraft. Note the curved fin-tip (not found on A-4Hs or Ns).

To supplement the Skyhawks lost by the IDF/AF during the Yom Kippur War, 46 A-4Es were quietly transferred from US Navy and Marine Corps units and flown to Israel from the American aircraft carrier USS *Independence*, sailing near Malta. These aircraft and the A-4Hs were modified as a result of lessons learned during the savage fighting, which led to the loss of more than 50 aircraft, mostly to ground launched, IR-directed missiles. One of the improvements was a tailpipe extension to reduce the signature of the exhaust heat, as well as internal avionics to signal the launching of radar-directed surface-to-air missiles. Chaff dispensers to misdirect the heat-seeking rockets were also retrofitted.

When the US Marine Corps was able to procure the greatly improved A-4M Skyhawk II, Israel requested that it be allowed to receive a version tailored to its specific requirements. This request was approved. The A-4N Skyhawk II was ordered and a total of 117 aircraft were delivered between 1972 and 1976. The type made its first flight on 8 June 1972 with John Lane. In addition to the 11,200-lb (49.82-kN) uprated Pratt & Whitney J52-P408 engine that powered the A-4M, the A-4N was outfitted with two 30-mm guns with 150 rounds each replacing the 20-mm guns, an Elliott HUD, a new weapons delivery system and a state-of-the-art

A-4H (as delivered)



system for detecting and then redirecting approaching missiles.

Israel has pursued a vigorous programme of updating its Skyhawk fleet and still considers them a vital part of its defence system. The update includes wing spoilers, landing drag chutes, and steerable nosewheel for the A-4Es, and replacing the 20-mm guns in the A-4E and A-4H with the 30-mm gun as used in the A-4N. The electronic countermeasures (ECM) defences have been improved, as has the navigation system. These improvements have also been made available to other countries that still operate the Skyhawk.

With the approval of the United States government, the Israeli government transferred 14 of its A-4Es and two of its TA-4Hs to the Indonesian air force in 1979, as well as a like amount in 1985.

Above: The A-4N was based on the A-4M designed for the USMC, but with many detail differences. Here one of the first aircraft built flies on a test flight over the Hoover Dam.

Right: All Israeli A-4s, such as this A-4H, were fitted in service with extended jetpipes that reduce the infra-red signature of the engine.

Below: Photographs of the TA-4H are rare. This Nevatim-based two-seater was used for weapons training and is seen with two dummy Mk 82 500-lb bombs. The TA-4H has been used as a bomber in actual operations.

US Navy Bureau Numbers assigned to Israeli Air Force (Heyl Ha'Avir) Skyhawks

A-4H 90 aircraft

Amount	From	To
48	155242	155289
34	157395	157428
8	157918	157925

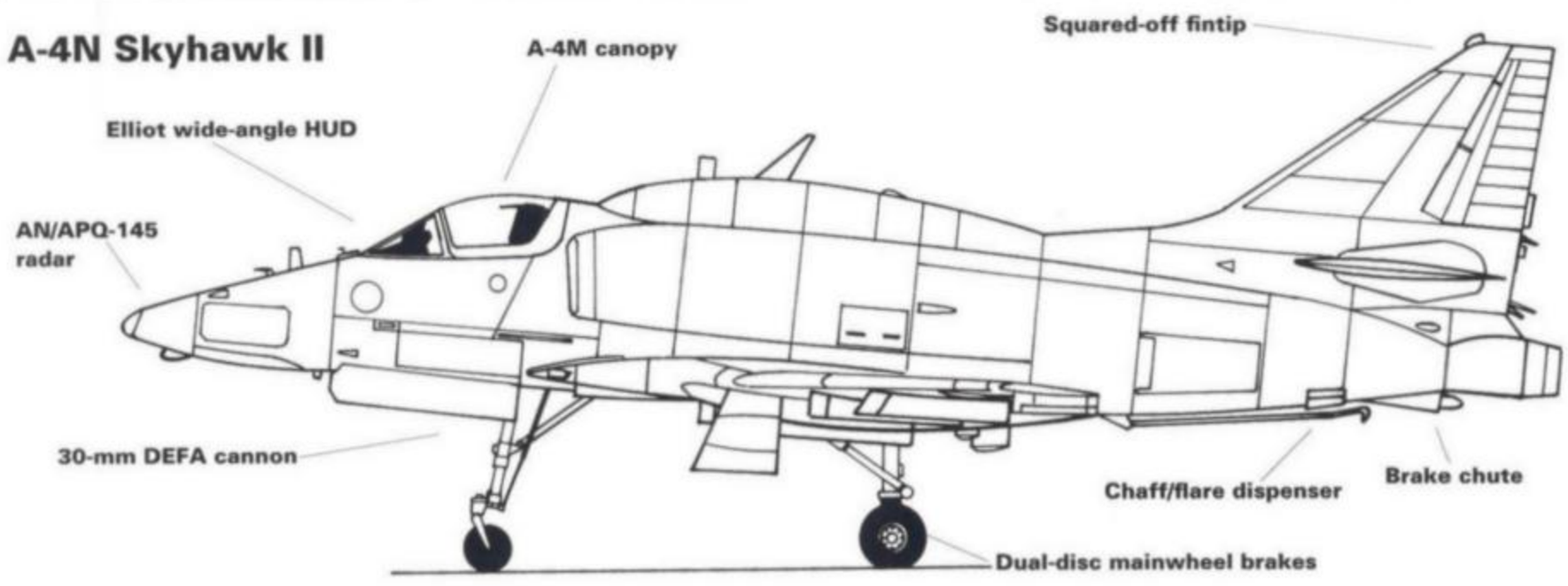
TA-4H 25 aircraft

Amount	From	To
6	157429	157434
4	157926	157929
11	159546	159556
4	159795	159798

A-4N 117 aircraft

Amount	From	To
18	158726	158743
18	159035	159052
24	159075	159098
12	159515	159526
26	159799	159824
19	159527	159545

The Skyhawk remains in service in Israel in diminishing, but still substantial numbers. Large quantities are also stored, as a war reserve, and for potential sale.



McDonnell Douglas A-4N Skyhawk No. 116 Squadron Israeli Defence Force/Air Force

Of the nations that have used the Skyhawk in combat, Israel has made the most use of Ed Heinemann's diminutive attack jet. In action almost as soon as it was delivered in 1968, the A-4 has been involved in every major conflict fought by Israel. In September 1969 a Syrian MiG-17 fell to the guns of an Israeli A-4 on a bombing mission, and a MiG-19 was reportedly downed by an air-to-ground rocket. In the 1971 Yom Kippur War, the six A-4 units flew more attack sorties than all other types combined, but with heavy losses to AAA and SAM defences.

Israeli A-4s
Following bitter combat experience when a number of aircraft were lost to shoulder-fired SAMs, the Israelis made many home-grown improvements to their Skyhawks. Chief among them was the tailpipe extension, which allowed the jet exhaust to cool before meeting the outside air, slightly further behind the main airframe structure, thus protecting vital parts from damage caused by proximity-fused warheads. Locally-designed ECM equipment was installed in the dorsal hump and elsewhere, and chaff/flare dispensers were fitted.

No. 116 Squadron
No. 116 Squadron became known as the 'Wire Cutters Squadron' due to its exploits in the Suez Campaign when its P-51s were used to cut Egyptian communications by flying through telegraph lines in the Sinai. The unit re-equipped with ex-French Mystère IVAs later in 1956 and flew them in the Six Day War, becoming the sole IDF Mystère unit in 1968. In 1970, the squadron converted to the Skyhawk, using some of the A-4Es supplied from USN stocks. These aircraft were heavily used in the Yom Kippur War. The A-4N arrived in 1975, and the squadron has used them ever since, today based at Nevatim.

A close-up of the DEFA 30-mm cannon shows the different fitment of this weapon compared to the Colt Mk 12 fitted to most other nations' A-4s.

A-4N
The A-4N featured many of the improvements introduced to the A-4M, such as the raised canopy and P-408 engine. The self-starter of the M was not fitted and the A-4N also had radar unlike the Marine Corps variant.

New Zealand (A-4K and TA-4K)

In the early 1960s, the Royal New Zealand Air Force undertook a programme to re-equip its forces. Although the transport and maritime wings were updated at that time, the strike forces were not immediately modernised because of their inability to select an aircraft that met their budget restraints. The prime choice to replace their ageing Canberras was initially the McDonnell Phantom. However, accounts from the Vietnam action brought glowing reports on the performance of the Skyhawks used on the carriers of the US Navy and the shore-based Marine Corps. By comparison, the Skyhawk could carry 9,000 lb (4082 kg) of weapons faster than the Canberras could carry their 6,000-lb (2722-kg) payload, and the price was right.

In September 1968, an RNZAF team visited the Douglas Aircraft Company to evaluate the Skyhawk for their strike mission. They returned to New Zealand with a positive recommendation and letter of offer from the US government. On 3 July 1968 the firm order was placed for 10 single-place and four two-place Skyhawks. They were to be designated as A-4K and TA-4K and were based on the A-4F and the TA-4F. The configuration included the aft avionics package on the A-4K only, a 14-ft (4.3-m) diameter drag chute and the installation of an AN/APX-72 IFF antenna on the upper vertical stabiliser which altered the shape to appear squared-off. Sidewinders could be carried on two of the five wing stations. A four-colour camouflage paint scheme of greens, brown and grey was also included.

First flight of the A-4K took place on 10 November 1969 with Walter Smith at the controls, followed by the TA-4K's initial flight on 5 December 1969, flown by John Lane. All 14 of the aircraft were delivered to New Zealand in 1970 aboard the USS *Okinawa*, an American helicopter assault carrier, and were assigned to No. 75 Squadron based at Ohakea. There they quickly settled in to a wide variety of activities including close air support, anti-shipping, interdiction, air defence and reconnaissance. No. 75 Squadron, in addition to its local missions, deployed to support joint operations with other Pacific Basin nations. Membership in the Southeast Asia Treaty Organisation (SEATO) provided various opportunities for joint exercises.

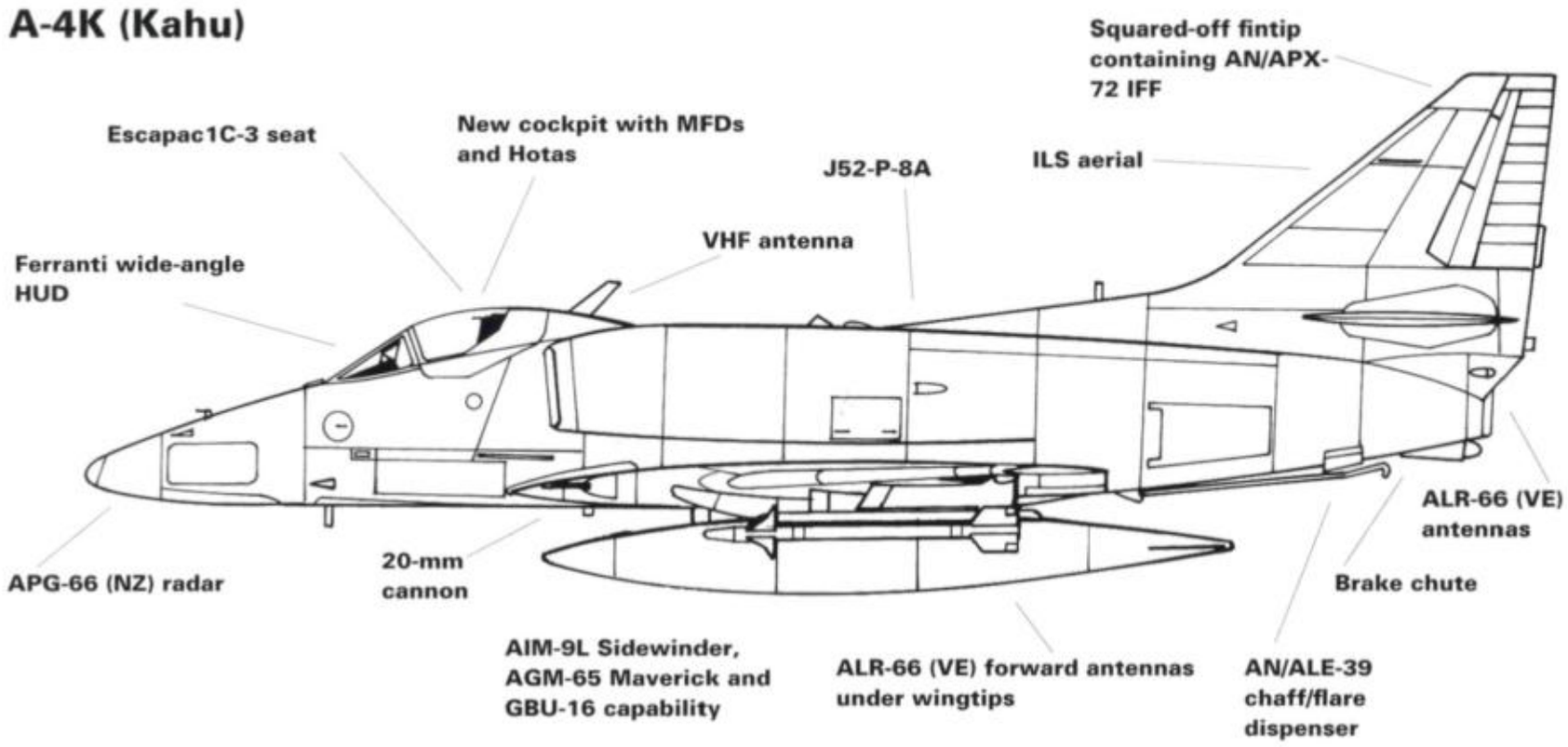
When the Royal Australian Navy decided to remove the carrier HMAS *Melbourne* from service in 1982, their A-4G and TA-4G Skyhawks were declared redundant; two years later the RNZAF picked them up to augment its fleet of A-4K and TA-4Ks. Ten aircraft and the available spares were involved in this transaction. These Skyhawks initially retained the grey colours of their former users, but were overhauled and partially modified to the standard of the

Above: the RNZAF's A-4Ks were delivered with the dorsal hump, but this was was actually empty due to lack of funding for more avionics. It made a useful baggage locker.

Left: In the late 1980s, the RNZAF updated its A-4 fleet with state-of-the-art avionics under Project Kahu (Hawk). Electronics miniaturisation is now such that this could be done while removing the dorsal humps. For a time, an updated A-4 or TA-4 could be identified by a swept-back dorsal VHF aerial.

Above: TA-4Ks wheel over Wellington in their delivery scheme with the short-lived silver fern roundel. The undernose fairing (for ALQ-100 ECM gear which was not fitted) was removed after a short period in service. Straight refuelling probes on all RNZAF A-4s were also replaced with 'cranked' ones.

A-4K (Kahu)



A-4 Export Variants

RNZAF and given new serial numbers. They were then assigned for service to Nos 2 and 75 Squadron.

After Australia had sold its remaining Skyhawks to New Zealand, the country entered into an agreement whereby the RNZAF's No. 2 Squadron was moved to Nowra, Australia in 1991 with six Skyhawks. This greatly benefited both countries, as it provided air defence support for Australia and superb training for the New Zealand personnel.

In 1984, the RNZAF began an evaluation of its future mission with respect to the suitability of new or used fighter and strike aircraft. Because of the high cost involved in new aircraft, it was decided that it would be possible to retrofit the 22 A-4s and still meet their increasing mission requirements. This could be accomplished by retaining the P & W J52-P8A engines but substantially upgrading the avionics capability of the Skyhawk to be comparable to the General Dynamic F-16 Fighting Falcon in the close air support/maritime attack roles. Under the Project Kahu name, the retrofit programme was instituted in 1986 to bring all of the Skyhawks to a level at which they could satisfactorily accomplish their desired mission well into the 21st century. This was undertaken at a cost proving to be one-sixteenth that of the funding that would have been required if new aircraft had been procured. The avionics changes to improve the maritime attack and close air support roles includes replacing the AN/APG-53A radar with the AN/APG-66NZ, installing the Litton LN-93 INAS, the Ferranti 4510 wide-angle HUD and the Vinten airborne video recording system, the General Instruments ALR-66 radar warning receiver and a Tracor ALE-39 chaff-flare dispenser. Weapons improvements included an advanced AIM-9L Sidewinder, the GBU-16 laser-guided bomb and the AGM-65 Maverick air-to-surface missile. Structurally, the updating also provided for a complete rewiring, a rewinging and the total rebuilding of the cockpit.

US Navy/RNZAF serial numbers

A-4K (total 10)

From	To	From	To
157904	157913	NZ6201	NZ6210

TA-4K (total 4)

From	To	From	To
157914	157917	NZ6251	NZ6254

A-4G to A-4K serials

BuNos	RAN	RNZAF
154903	882	NZ6211
154904	883	NZ6212
154905	884	NZ6213
154908	887	NZ6214
155052	871	NZ6215
155061	874	NZ6216
155062	876	NZ6217
155063	877	NZ6218

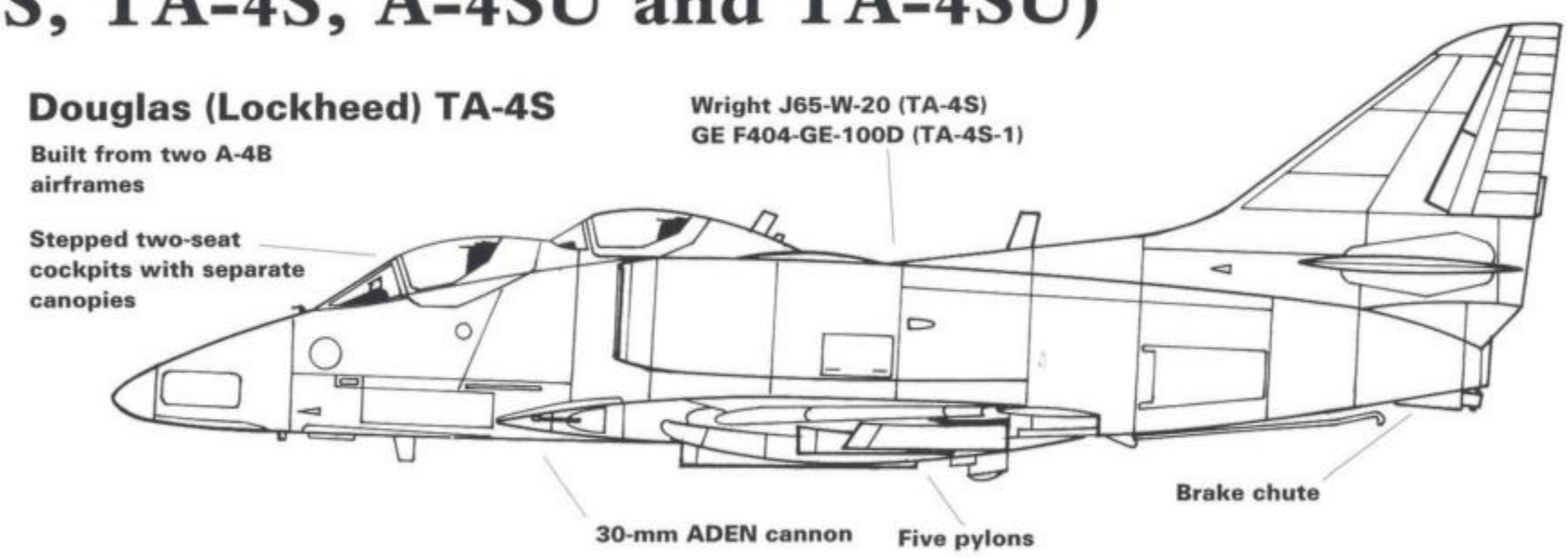
With the Kahu update, the RNZAF's A-4s have similar capabilities to the F-16, if not the speed. These No. 2 Sqn aircraft are now based at Nowra in Australia, ironically, the former shore base of the RAN's A-4Gs.

TA-4G to TA-4K serials

BuNos	RAN	RNZAF
154910	880	NZ6255
154911	881	NZ6256

Singapore (A-4S, TA-4S, A-4SU and TA-4SU)

The efforts of the US government to dispose of redundant A4D-2 Skyhawks proved fruitful in 1972 when the Singapore government purchased 40 aircraft that were parked at the Department of Defense storage area at Davis-Monthan AFB in the desert of southern Arizona. Lockheed Air Services was chosen to overhaul and update these aircraft with over 100 modifications to meet the requirements of the Republic of Singapore air force. This was to include the installation of the 8,400-lb (37.37-kN) thrust rated Curtiss J65-W-20 turbine engine, a 20 per cent increase in power from the earlier J65-W-16A. Also to be incorporated were the wing lift spoilers that were introduced in the US Navy's A-4F. This greatly facilitated landing in crosswinds as it spoiled the lift and firmly planted the aircraft on the landing surface. Other changes included replacing the 20-mm Mk 12 cannon with 30-mm ADEN cannons, a Ferranti lead-computing optical gunsight and drag chute to reduce the landing roll. In addition, the communication, radio and navigation systems were replaced with new solid-state equipment. Two additional wing stores were added to increase the number to five. These were wired for Sidewinder missiles which allowed the Skyhawks to perform an air defence role. Lockheed at Ontario, California modified eight Skyhawks



Below left: Singapore's A-4s flew in this overall grey scheme when initially used in the US for pilot training. Since delivery in 1973, the aircraft have been updated twice.

Singapore's TA-4Ss are fitted with two separate single-seat canopies. This was done for logistic reasons, although the rear unit has a different frame and windscreen.

Singapore's Skyhawks have served with 142, 143 and 145 Squadrons at Tengah. Sidewinders could be fitted for a secondary air defence role.

to this A-4S configuration while the remaining 32 aircraft were shipped to Singapore to be refurbished by Lockheed Air Services Singapore, beginning in February 1974. Lockheed was also contracted to provide maintenance and logistics support and to assist with crew training.

The A-4S made its first flight on 14 July 1973 after refurbishment had started in the previous September. After proving flight tests, it was delivered, along with the balance of the aircraft reworked at Ontario, to the naval air station at Lemoore, California where they provided type training for the RSAF pilots and crews.

A unique two-place trainer was created also by Lockheed. In order to standardise on a common engine for the entire fleet (the factory-built trainers were powered with the P & W J52 engines) – the J65 – A-4B airframes were modified by adding a 28-in (71-cm) fuselage section and a second A-4B canopy aft of the normal canopy, raised to allow better forward visibility for the second or instructor pilot. This was in contrast to the American approach, wherein the two positions were covered by a common enclosure. Lockheed reworked seven A-4B airframes to this TA-4S configuration, which still retained the full operational capability of the single-place A-4S.

The Singapore air force was so impressed with the performance of the A-4S aircraft that they purchased an additional 70 A-4Cs from the US surplus stocks in 1980 and shipped these to the government-owned Singapore Aerospace Maintenance Company (SAMCO) for rebuilding. With the exception of the retention of the original 20-mm guns, the shorter nose and the straight inflight-refuelling probe of the A-4C, these aircraft mirrored the modifications of the earlier A-4Bs. Another 16 A-4Bs were also obtained for conversion into eight TA-4S aircraft.

In a further upgrading of the capabilities of the Skyhawk, the A-4S versions were re-engined with non-afterburning General Electric F404-GE-100D turbofan engines. This increased the power 29 per cent from 8,400 lb (37.37 kN) of the J65 to 10,800 lb (48.04 kN) and reduced the fuel consumption, thus increasing the range. Maintenance time was also lowered from 10 maintenance man hours per flight hour to one. This A-4S-1 version first flew on 19 September 1986. This model was also chosen for the RSAF flight demonstration team, known as the 'Black Knights'.

Part two of the revitalisation programme, under which the aircraft were designated as A-4SU, included the upgraded engine. The programme was an ambitious effort to enhance the operational capabilities by improving the weapons delivery and navigational systems. This consisted of the installation of a GEC-Marconi 4150 HUD, new HDD, Litton LN-93 laser INS and the Maverick missile interface.

This upgrading resulted in the following changes: Maximum take-off weight increased by 8.8 per cent from 22,500 lb (10206 kg) to 24,500 lb (11113 kg); payload increased by 23 per cent from 11,300 lb (5126 kg) to13,950 lb (6327 kg); rate of climb by 131 per cent from 8000 ft (2438 m)/min to 18,500 ft (5640 m)/min; take-off distance was reduced by 33 per cent from 4,500 ft (1372 m) to 3,000 ft (914 m); the thrust:weight ratio increased by 36 per cent from 0.75 to1.02: and maximum endurance on internal fuel rose from 3.5 hours to 4.3 hours, a 23 per cent improvement.

The A-4SU version is barely distinguishable from the original A-4S, particularly from the starboard side. The large VHF aerials behind the cockpit and on the nosewheel door are recognition features of the SU, as is the slightly altered jet pipe.

The prototypes of the A-4SU and TA-4SU were displayed at the Asian Aerospace Exhibition in the colours of the 'Black Knights'. Beside the single-seater here is an F404 engine.

Known Republic of Singapore Air Force A-4S (S-1, SU) Skyhawk BuNos

142101,142119,142125,142131,142711,142746,
142751,142770,142771,142774,142800,142819
142832,142840,142850,142870,142876,142882
142908,142942,144874,144926,144971,144974
144980,145013,145030,145038,145046,145056
145059,145110,147779,148521,148526,148603
149498,149537

TA-4S (S-1, SU)

144979,144894,145021,145043,145047,
147742,148525,148483

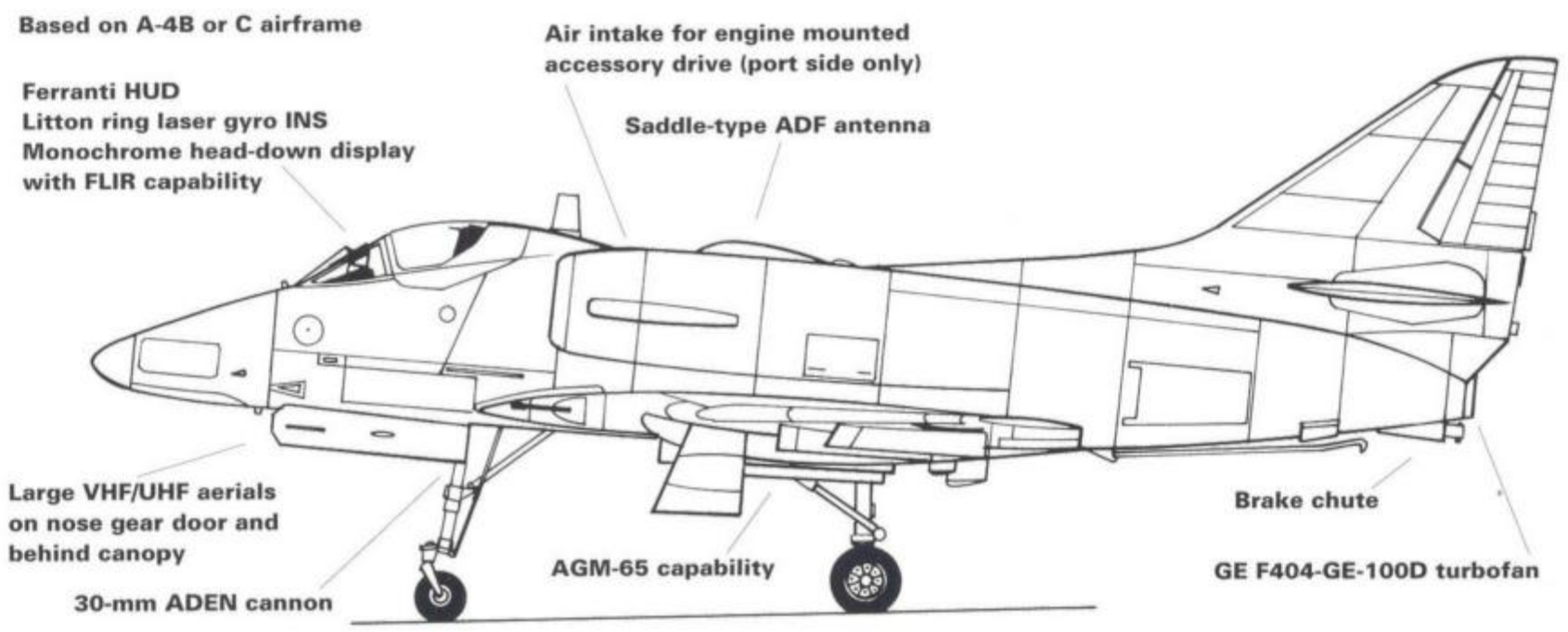
Known Republic of Singapore Air Force A-4S (S-1, SU) Skyhawk serial numbers

600,601,602,603,604,605,606,607,616,617,618,61
9,620,621,622,623,630,631,632,633,634,635,636,6
43,644,645,646,647,648,649,650,656,657,658,659,
660,679,680,681,682,683,914,917,918,919.923,92
4.927,928,933,936,937,938,939,940,941,942,945,9
46,947,956,957,960,961,967,969,970,971,972,973,
974,975,976,977,981,983,985,991,992,993,994

TA-4S (S-1, SU)

651,652,653,687,688,689,690,900,901,902,903,90
4,905,906,907,908,909

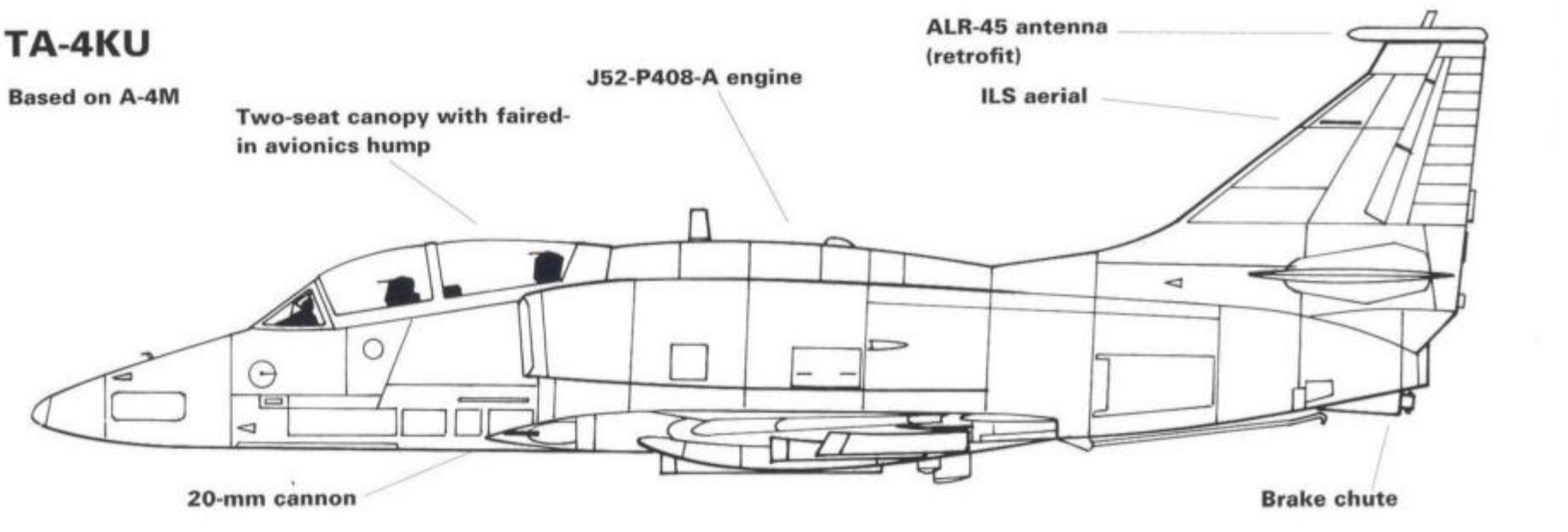
A-4SU (Singapore Aircraft Industries Super Skyhawk)


Based on A-4B or C airframe
Air intake for engine mounted accessory drive (port side only)
Ferranti HUD
Litton ring laser gyro INS
Monochrome head-down display with FLIR capability
Saddle-type ADF antenna
Large VHF/UHF aerials on nose gear door and behind canopy
30-mm ADEN cannon
AGM-65 capability
Brake chute
GE F404-GE-100D turbofan

Left: Two A-4KUs formate during a test flight, one wearing temporary US insignia. According to Douglas test pilots, the Kuwaiti A-4s with their big P408 engine were the sweetest of all Skyhawks to fly.

An A-4KU is shown in Kuwait before the 1991 Gulf War and without the fintip ALR-45 aerial. This angle gives a good view of the variable-incidence tailplane common to all Skyhawks.

Kuwait (A-4KU and TA-4KU)



After two years of negotiations, the Kuwaiti government announced in November 1974 that it intended to purchase 36 Skyhawks, 30 to be single-place and the remaining six to be two-place. The aircraft were to be designated as A-4KU and TA-4KU, respectively. Many factors entered into the decision to buy the Skyhawks rather than the Anglo-French Jaguars or the American LTV A-7 Corsairs which were the major competitors. Authorisation by the US government to also purchase AIM-9 Sidewinder air-to-air missiles for use on the A-4s was crucial, as was a fixed-cost contract that the Jaguar builders could not make. In addition, the Kuwaitis wished to purchase several batteries of Hawk air-defence missiles built by Raytheon in the US. The continued successful use of upgraded Skyhawks by Israel was also a major selling point in buying an airframe that had made its first flight 20 years before.

The A-4KU configuration was based on the A-4M Skyhawk II that was in the process of being delivered to the US Marine Corps, which had chosen that aircraft over the LTV A-7 for its close air support mission. The necessary equipment to launch nuclear weapons and some ECM gear that was still considered classified by the US government were deleted, as were provisions for Shrike and Walleye missiles. The communication equipment was especially tailored for the particular requirements of the customer.

The TA-4KU was unique in that these six aircraft were the only two-place versions equipped with the 11,200-lb (49.82-kN) thrust Pratt & Whitney J52-P408 turbine engine that was installed in all Skyhawk IIs. All other two-seaters were equipped with the PW J52-P-6 or P-8 as they left the factory. (Some trainers revised for Singapore or Malaysia were modified to take the Wright J65-W-20 Sapphire engines. Also, the TA-4S-1s were re-engined with the GE F404 developing 10,800 lb/48.04 kN of thrust.) It was also equipped with the aft avionics package similar to that of the OA-4M. The TA-4KU ordnance capability was the same as that of the single-place A-4KU, losing only 120 US gal (454 litres) of internal fuel for the space taken up by the second crewman.

After being given the authority to proceed on 10 January 1975, Douglas test pilot Fred Hamilton made the first flight of the A-4KU on 20 July 1976 and of the TA-4KU on 14 December 1976. Douglas Aircraft then set up a training programme at Yuma, Arizona for Kuwaiti pilots and crewmen at the request of US government, using loaned TA-4J trainers from the US Navy Training Command. All 36 aircraft were ferried to Kuwait during 1977 and 1978 where they were assigned to Nos 9 and 25 Squadrons at Ahmad al-Jabr. In 1984, the surviving 29 aircraft were involved in negotiations with the US government and the McDonnell Douglas Corporation for trade-in credits for 40 new F/A-18 Hornets. Before this agreement could be carried out, the Persian Gulf conflict erupted in 1990 and the Skyhawks went to war. When its airfields were rendered useless, the Kuwaiti air force continued to strike the approaching Iraqis using deserted highways as runways. On 4 August, it was forced to fly to Dhahran, Saudi Arabia to continue its action. Operating as the Free Kuwaiti Air Force, it was integrated into the RSAF and continued to take the battle to the attacking Iraqis. During the combined Desert Shield and Desert Storm, the FKAF flew 1,361 sorties, losing only one aircraft.

Twenty-three aircraft (19 single-place and three two-place Skyhawks) survived the war and were put up for sale per the pre-war agreement. However, the total loss of their spare parts has made the sale difficult and they are still stored at this time.

USN/Kuwaiti serial numbers

A-4KU

Amount	USN	Kuwait AF
30	160180 to 160209	801 to 830

TA-4KU

6	160210 to 160215	881 to 886

Kuwait's Skyhawks saw action at the end of their careers, flying from Saudi Arabia. The surviving aircraft are preserved or stored pending sale, possibly to Botswana.

With an instrumentation boom fitted to the refuelling probe, a TA-4KU takes off on a test flight from Palmdale. Visible on the intake trunk is the exhaust for the self-starter unit.

Malaysia (A-4PTM and TA-4PTM)

In 1980, the Royal Malaysian Air Force (Tentara Udara Diraja Malaysia - TUDM) opted to take advantage of the low price asked by the US government for surplus Skyhawks when it purchased 25 A-4Cs and 63 A-4Ls. The remaining service life of these aircraft stored at Davis-Monthan AFB in Tucson, Arizona was predicted to be 14 years. The RMAF's intention was to refurbish the aircraft into 54 single-place and 14 two-place versions with updated avionics and added weapons capability. However, a temporary hold on this sale by the US government resulted in an escalation of modification costs due to inflation and the RMAF decided to update only 40 aircraft, including six as two-place Skyhawks.

The Grumman Aerospace division at St Augustine, Florida was selected to rework these aircraft, beating out Vought, McDonnell Douglas and Lockheed Air Services for the job. The contract was signed on 15 December 1982, with the work to be spread over three years. This included a complete rewiring, and two additional wing external store locations placed outboard to make a total of five (similar to the A-4E and later Skyhawks). Each of these added hardpoints was rated at a 1,000-lb (454-kg) load capacity. Refurbished J65-W-20 engines and some new avionics were also installed. The avionics upgrade consisted of maintaining the existing navigation and radar altimeter system and installing the AN/ARN-118 TACAN, a Saab RGS-2A lead computing weapons sight, a Lear Siegler altitude heading reference system and an AN/ARC-164 UHF transceiver. The external configuration also included the aft avionics package which was standard for the A-4L but not for the A-4C. The cockpit canopy was enlarged similar to the A-4M configuration and a drag chute was installed in the aft lower fuselage. Provisions were also made to carry AIM-9 Sidewinder missiles and the AGM-65 Maverick for an air defence role to complement the maritime patrol and close air support objectives. The two-place Skyhawks were to be created by inserting a 28-in (71-cm) plug into the fuselage. They would have a single canopy, similar to Douglas-built TA-4s.

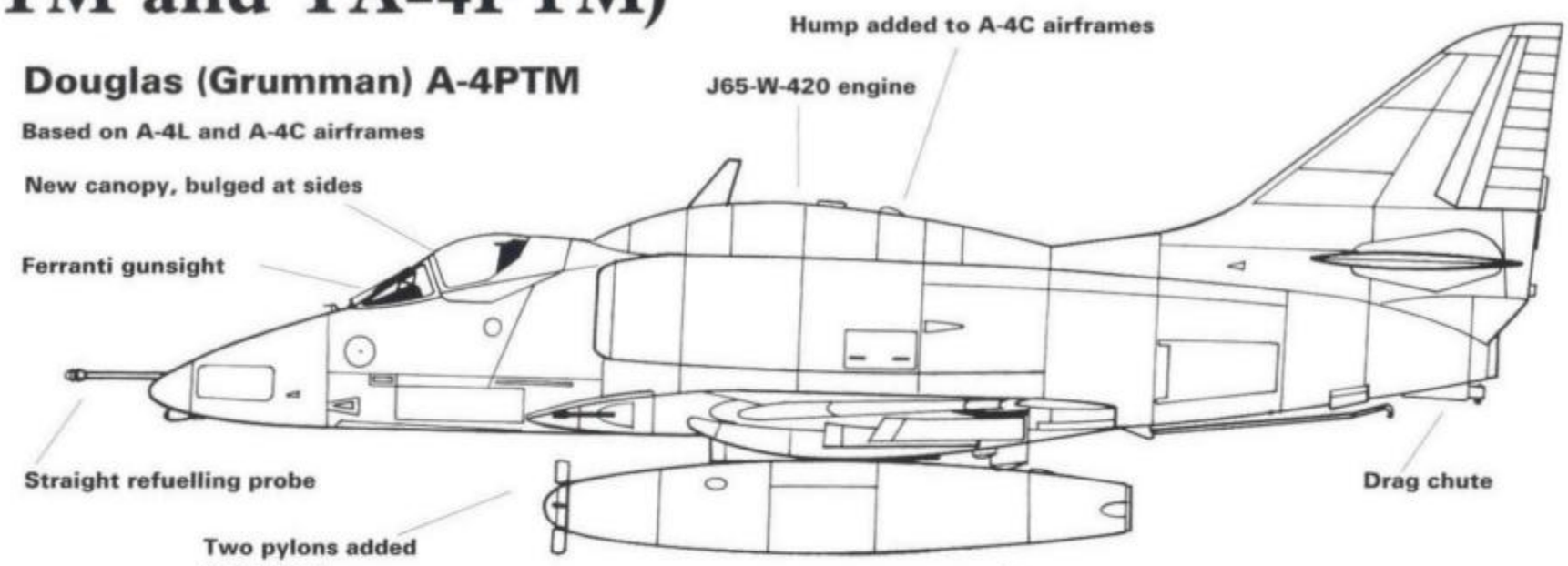
Deliveries of the A-4PTM and TA-4PTM to the RMAF was initiated in 1985 and completed in February 1986. They were based with Nos 6 and 9 Squadrons, located at Kuantan. The service of the A-4PTM (Peculiar to Malaysia) was limited in 1989 when it was announced that the aircraft would be withdrawn from operational duties prior to the planned date of 1995. They were to be replaced with British Aerospace Hawk Mk 208s in late 1994.

The RMAF retained six Skyhawks for operational duties as tankers for the single-place Hawks, using a centreline external buddy store. The tanker A-4 could transfer the fuel from the 300-US gal (1136-litre) buddy store tank as well as from its internal and external tanks to a receiver aircraft.

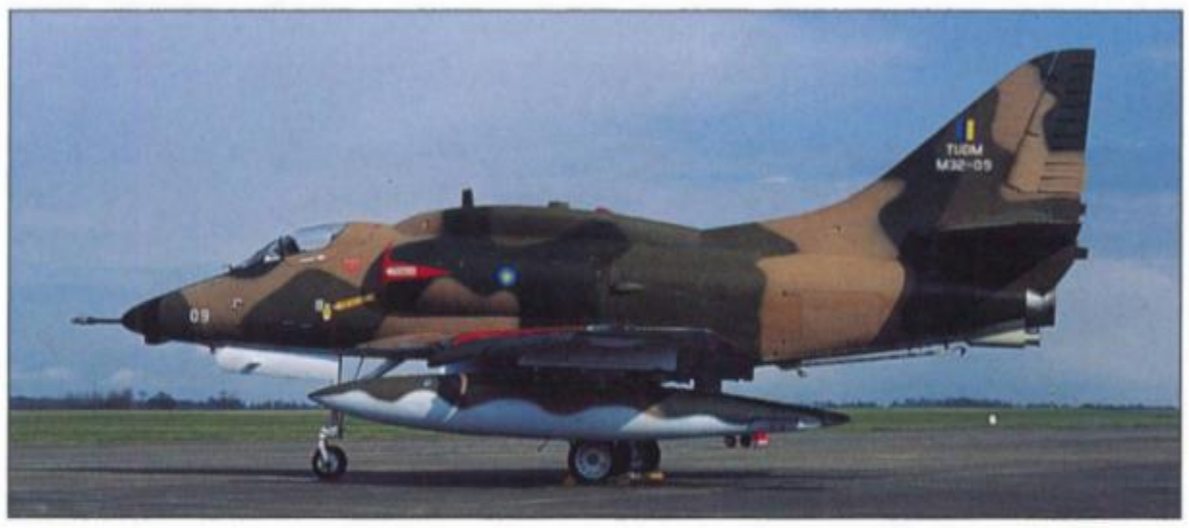
The serial numbers of M32-01 through 06 were assigned to the TA-4PTM aircraft, and M32-07 through -40 were applied to the A-4PTM. US Navy BuNos for these aircraft were (not necessarily in order):

A-4C: 145119, 145121, 145141, 148555, 148588, 148611, 149531 and 149626

A-4L: 145065, 145078, 145092, 145101, 145103, 145114, 147703, 147706, 147736, 147780, 147782, 147796, 147802, 147807, 147827, 148306, 148436, 148479, 149497, 149505, 149518, 149536, 149551, 149573, 149583, 149594, 149607, 149608, 149626, 149630, 149633 and 150593


Douglas (Grumman) A-4PTM
Based on A-4L and A-4C airframes
New canopy, bulged at sides
Ferranti gunsight
Straight refuelling probe
Two pylons added (total five)
AIM-9J and AGM-65A capability
Hump added to A-4C airframes
J65-W-420 engine
Drag chute
Douglas D-704 buddy pod for tanker role

Right: An A-4PTM in a primer coat takes off on a test flight from St Augustine. Malaysia's Skyhawks have had a short service career compared to those of other users.



Above: The Malaysian Skyhawks were delivered by a circuitous route, travelling from Florida to Malaysia eastbound. The journey included a stop at Mildenhall in England.

Above right: TA-4PTMs are checked just before the delivery flights. In Malaysian service, a low-visibility colour scheme was subsequently applied.

Right: The TA-4PTM is an interesting hybrid. It is a two-seater based on an A-4C airframe, but features A-4E-style intake lips and five pylons.

Indonesia (A-4E and TA-4H)

In 1977, after 10 years of tight budget restraints, the Tentara Nasional Indonesia - Angkatan Udara (Indonesian Armed Forces - Air Force) began a modernisation plan. Prior to that they had relied heavily on Soviet equipment, but this was withdrawn because of persistent spares shortage. One of the first Western-built aircraft considered for the Indonesian Armed Forces was the Douglas A-4 Skyhawk. In November 1979, they announced an agreement, struck with US approval, to obtain 14 A-4Es and two TA-4Hs from surplus Israeli stocks. Subsequently, an agreement was also negotiated with Israel for delivery of a further 16 single-seaters in 1985. These aircraft were assigned to 11 and 12 Squadrons located at Iswahyudi (and later Hasanuddin) and Pekanbaru, respectively.

Tentara Nasional Indonesia - Angkatan Udara (TNI - AU); Indonesian National Army - Air Force serial numbers

A-4E (first batch)

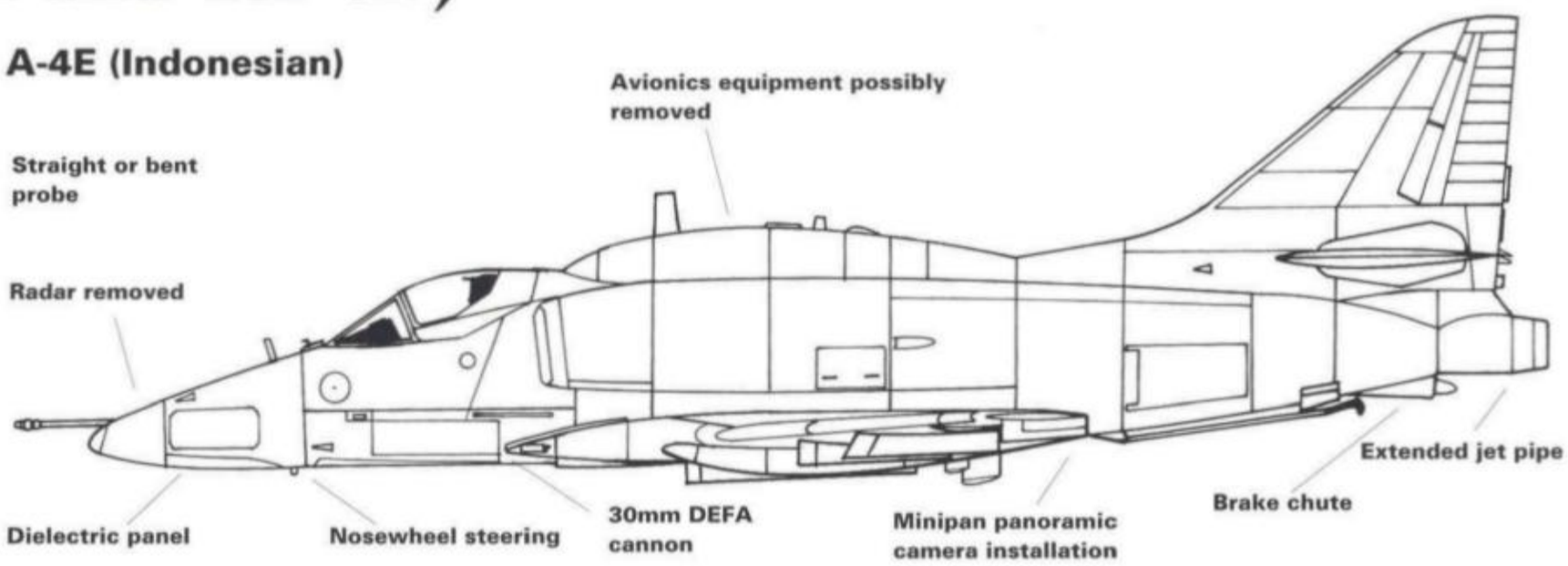
TT-0401	TT-0402	TT-0403	TT-0404
TT0405	TT0406	TT-0407	TT-0408
TT-0409	TT-0410	TT-0411	TT-0412
TT-0413	TT-0414		

TA-4H

TL-0415	TL-0416

A-4E (second batch)

TT-0431	TT-0432	TT-0433	TT-0434
TT-0435	TT-0436	TT-0437	TT-0438
TT-0439	TT-0440	TT-0441	TT-0442
TT-0443	TT-0444	TT-0445	TT-0446



Right: Indonesia's ex-Israeli Skyhawks serve with two units. They have seen much action since 1983 on anti-guerrilla operations in East Timor and Papua New Guinea.

Below right: One of the two Indonesian TA-4H aircraft is seen at Halim-Perdanaku-suma in 1995.

Below: The Indonesian Skyhawks have had three distinctive colour schemes, including this blue/grey scheme worn on 11 Sku A-4Es.

Skyhawks that never were

Douglas Aircraft Company continually worked on studies to improve the performance and capabilities of the Skyhawks. Its marketing group constantly liaised with key Navy and Marine personnel to stay aware of current and future requirements. These requirements were transmitted to the upper management of the company who then decided on a response. The amount of effort was tempered by the allowable company research budget and the extent to which a realistic chance of funding by the customer existed. The success of this strategy was illustrated by the long (27) years of production. However, not all of the Douglas Skyhawk proposals to the Bureau of Weapons (BuWeps, formerly BuAer.) resulted in production.

A4D-3: One proposal that was funded but then cancelled was the A4D-3. It was generated by the desirability of a greater range and the capability to attack through

The A4D-3 was a proposal based on improvements to the A4D-2 (A-4B) airframe, including a refuelling probe and the J52 engine. The intakes remained flush with the fuselage in this impression.

foul weather and shrouded terrain. Radar would be needed to penetrate beyond mountains, in addition to an autopilot for instrument flight. The Navy had developed an all-attitude bombing and navigational system which appeared to make this possible. A major factor in this improved Skyhawk was to be a new engine, the Pratt & Whitney J52, which would develop 10 per cent more power than the then-installed J65, with considerably less fuel consumption. Also, the J65 was a mature design with little growth potential contrasted with the new J52. Douglas was given a development contract for four aircraft in 1957.

However, before the design could be completely released from engineering, the US Navy had to reconsider its situation. An austere budget had forced the development of the J52 engine to be slowed. This resulted in the cancellation of the production of the A4D-3 aircraft. (An additional six Bureau numbers had been allocated for planning purposes and were also cancelled.) To fulfil the valid requirements for additional A-4 aircraft, a compromise aircraft was developed which retained the J65 engine and was designated as the A4D-2N.

The A4D-3 actually made it to the mock-up stage, and had serial numbers allocated before being cancelled. Many features of this project later appeared on the A-4E and subsequent variants.

Later, much of the A4D-3 design was incorporated into the A4D-5 (A-4E) version.

US Navy Bureau Numbers (Cancelled)

Amount	From	To
10	145157	145156

A4D-4: The A4D-4 was a 1958 proposal for a long-range all-weather attack aircraft with the primary purpose of delivering a special weapon at low altitude. The wing shape was changed from a delta configuration to a moderately swept, tapered design incorporating 2 drag-reducing 'Whitcomb Bodies'. Since the wingspan was increased 10 ft (3 m) from the standard A-4, it was necessary to fold the outer wing panels to meet the carrier elevator size limitations. Seven hardpoints were to be installed under the wing for external ordnance, fuel, and special stores. This resourceful project only gathered dust in the engineering vaults because the primary customer, the Navy, could not provide funding for development.

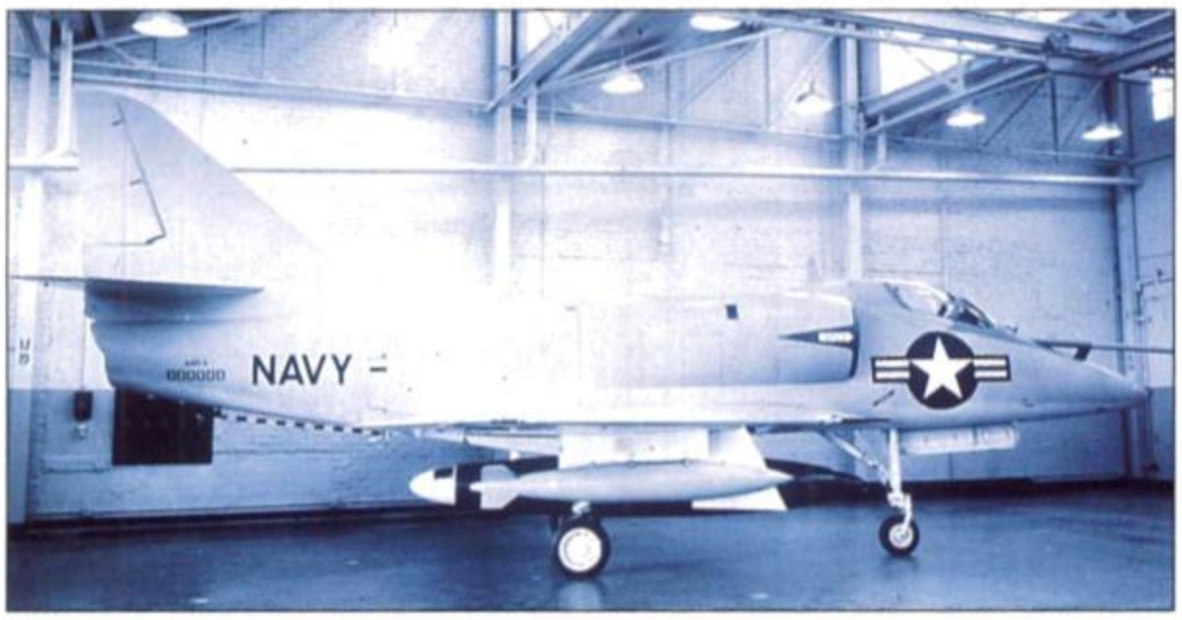
The A4D-4 would have been a very different Skyhawk, with a folding, tapered wing and seven hardpoints.

VAL proposals: In the early 1960s, BuWeps had two programmes for future light attack aircraft systems that it was studying in-house. The VAX programme was an ambitious continuing project that was advancing the state of the art of that day. Much funding would be necessary to develop the required hardware to allow the programme to come to fruition. A short-term solution was known as the VAL, based on aircraft then in the US Navy inventory, for about 100 aircraft to buy time until the VAX could be brought on line. On 24 May 1963 the Chief of BuWeps advertised for Request For Proposals to fulfil the requirements for the VAL. It appeared that the VAL was really based on a significant improvement of the A-4 with a new TF30 engine. Douglas had already submitted an unsolicited proposal known internally as the A4D-6 or A-4F under the new Department of Defense designation system. (This should not be confused with the later A-4F that was put into production.) This in-house study was reworked to reflect the additional requirements of the VAL RFQ. The competition was Ling-Temco-Vought (LTV) with a version of its F-8 Crusader, North American with the FJ-5 and Grumman with a stripped version of its A-6 Intruder. Lockheed and Boeing also asked for RFQs.

By August 1963, the marketing personnel reported that it seemed the actual numbers required would be 500 to 1,000, and that the VAX would be pushed even further into the future. This report forced the manufacturers to further sharpen their pencils in an effort to be competitive.

Douglas was shocked when LTV was announced as the winner of the competition with the A-7A, a version of the F-8E Crusader. It was clearly more cost effective. The Navy intended to rush the A-7 into production and cancel the intended 120 A-4 production for each of FY 1965 and 1966 contracts. However, due to the Vietnam commitments and some A-7 production difficulties, the future A-4 production was not cancelled and it continued with improvements to eventually outlast the A-7 in the operating inventory of the US Navy.

The CA-4F was a proposed two-seat attack variant, based on the A-4F with seven hardpoints. Although it resembled the OA-4M, the CA-4F would have had seven pylons and the 'hump' would have been a conformal fuel tank.



In addition to the eight nations who bought the Skyhawk, Douglas offered it to a number of other friendly nations. Company artist R. G. Smith produced impressions of A-4s in many unusual colour schemes, including (clockwise from below): Greece , Indian navy, Switzerland, The Netherlands, and Lebanon.

Skyhawks for sale

A Decade of Air Power

Royal Air Force Fighters 1920–1929

The 1920s were a period of austerity for the young Royal Air Force: at the start of the decade it had just two fighter squadrons. By 1930 there were a dozen, but the equipment was little better than that which had fought the Great War. Nevertheless, the small force had built on its wartime traditions to create a golden age for the RAF fighter squadrons.

Above: The Sopwith Snipe was the mainstay of the single-seat fighter squadrons until 1925/26.

Below: An all too familiar sight on RAF fighter airfields was nosed-over aircraft, such as this No. 3 Sqn Snipe at Ambala. The Siskin was particularly prone to nosing over, accounting for the RAF-peculiar facial disfiguration known as the 'Siskin nose'.

Below: Of the two fighter squadrons still extant in 1920, one (No. 1) was based in India. It was then posted to Iraq as part of the policing force. Here its Snipes are seen near Baghdad in 1926, shortly before its disbandment (and subsequent reformation as a home defence squadron).

As the Royal Air Force entered the brave new decade of the 1920s it was insignificant and unwanted. The 'war to end all wars' had ended barely one year before, and people of all nations were heartily sick of war, fighting and anything associated with it. The extensive casualty lists of the previous years meant that the majority of families – certainly in the United Kingdom – had lost at least one member. The prospect of another war in the foreseeable future was almost incomprehensible.

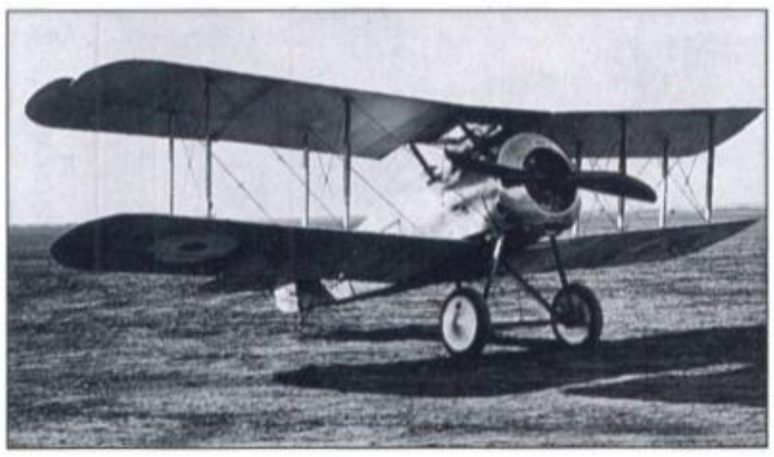
Germany had been flattened in every sense and it was difficult to imagine how it would ever become a viable fighting force again; all the combatant nations were exhausted and in need of years of rebuilding to be stable once again. The only other large European nation, Russia, was in the throes of a revolution which dictated that the country would take years to become a viable world force. So, peace was the obvious priority in the years ahead, a peace which had to be worked at diligently to provide a higher than subsistence-level existence for the members of the European nations whose economies had been geared wholly to the recent great battles.

In this context, the Armed Forces of the Crown barely rated any place at all in the thinking or the planning of anyone in the country. Even in the services themselves, the RAF was in a difficult position. From the beginning, the Army and Navy had not wanted the creation of a separate Air Force and it had only been the concerted action of Sir Hugh Trenchard that had prevented these two jealous services from swallowing up the parts of the RAF that had been theirs and had been purloined (in their view) to create the infant Royal Air Force in April 1918. Now, they were determined to get them back.

Peacetime force

Had it not been for the unwavering vision of Sir Hugh Trenchard at this particular time, backed by the arrival at the Air Ministry of Winston Churchill, the Royal Air Force would have been perished in 1919. They successfully pushed their ideas and Trenchard began to build a permanent peacetime force which would justify itself by its excellence. He was wise to build small, opting for quality rather than quantity, for he would have been allowed nothing else!

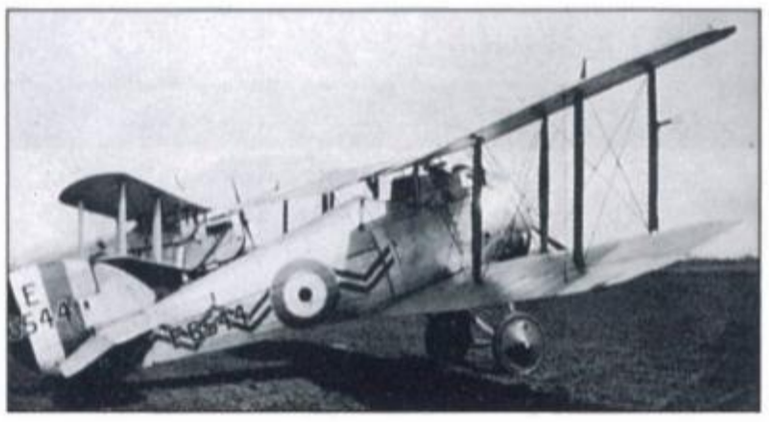
When examining the fighter in the 1920s' RAF, the Sopwith 7F.1 Snipe is the first to come to notice. The Snipe had been ordered during World War I as the latest development in the long line of Sopwith's successful rotary-engined biplane fighters. It carried the standard armament of two 0.303-in machine-guns firing through the propeller disc and, as such, had come into the RAF as a Sopwith Camel replacement. For the next five years, the Royal Air Force had to rely upon the Sopwith Snipe



Above: A characteristic feature of the Snipe was the horned elevators. This is a No. 1 Sqn aircraft, seen at Hinaidi in Iraq.

Above: No. 25 Sqn's Snipes were dispatched to San Stefano during the Turkish troubles in 1922. Here an aircraft overflies Constantinople.

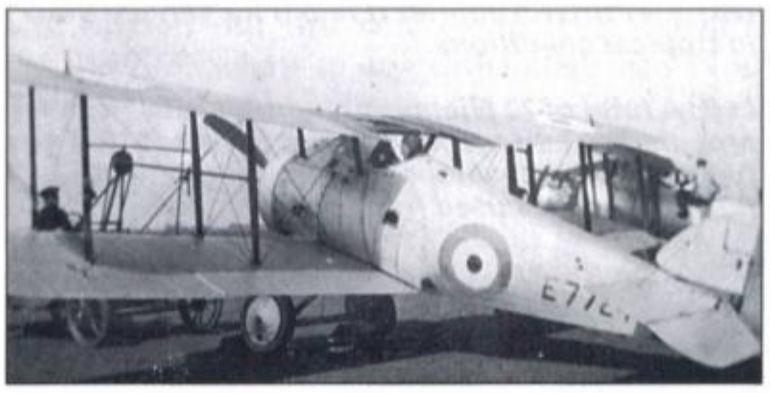
Above: No. 56 Sqn reformed on Snipes in 1920 at Aboukir, but was later disbanded. Here its aircraft are seen at San Stefano in 1922.



Above: The unit markings which became so well known were introduced in the Snipe era. The black zig-zags were the trademark of No. 17 Sqn.

Above: No. 111 Squadron introduced a black line as its squadron markings. This Snipe has a fuselage number added for an air race.

Above: No. 32 Sqn added its blue/white squadron markings from nose to tail on this Snipe. Of interest are the red/blue night-fighting roundels.



Below: Photographed at Henlow, this Snipe is from No. 43 Squadron, seen hooked up to the primitive yet effective Hucks starter.

as the backbone of its fighter force. It was opportune that of the 4,500 Snipes ordered not all were cancelled, and in the event 1,100 were built and delivered to the RAF. Without these aircraft, the early RAF fighter force would have been in a troubled condition.

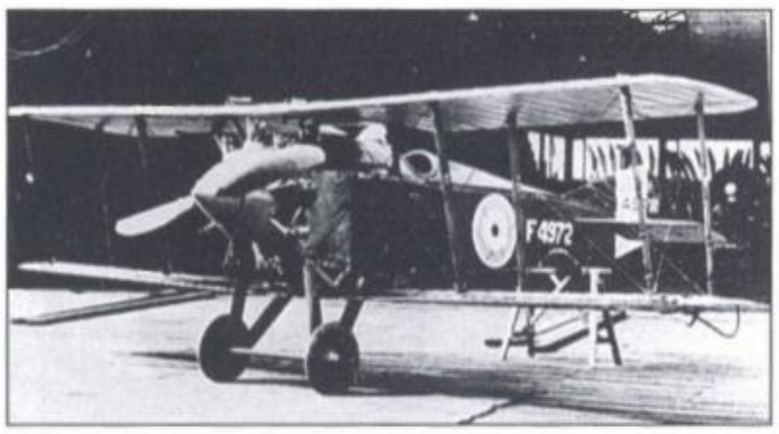
The so-called 'fighter force' that existed on the first day of the 1920s consisted of No. 1 Squadron at Risalpur, India with the Sopwith Snipe, and No. 203 Squadron at Scopwick, Wales with the Sopwith Camel. The belief that there would be no more European wars prompted the rationale that fighter aircraft were only needed to assist the general-purpose squadrons keeping the tribesmen quiet on the outskirts of the British Empire. Accordingly, three weeks into 1920, No. 203 Squadron disbanded at Scopwick, leaving the United Kingdom without any air defence whatsoever. Not that one squadron of Sopwith Camels would have been much use; it was simply a token.

Right: The Snipe remained in service until 1927 with training units such as the Central Flying School. About 40 were dual-control trainers.

A further gesture towards the safety of the United Kingdom was made on 26 April 1920 when, at Hawkinge, No. 25 Squadron was reformed. Instead of following its previous existence as a bomber squadron, it was formed with Sopwith Snipes and tasked with the defence of Great Britain. This did not require any new orders from the impoverished British aircraft industry, for the RAF had over 500 Snipes to hand, most of them in store. During that year the first of the RAF Pageants was inaugurated at Hendon. History does not record whether

Type 1 S.S. Fighter

Issued in early 1918, the Type 1 Single-Seat Fighter requirement brought forth a wealth of responses from the UK's aviation industry. In addition to those represented here, other competitors were the Sopwith 8F.1 Snail and Snark, and the Nieuport Nighthawk, designed by H.P. Folland. The end of the war removed the urgency from the programme, and it was not until 1919 that a production order was granted to the Nighthawk. The Nighthawks were built by the Gloucestershire Aircraft Co. (later Gloster), after the company bought the Nieuport concern. Many were re-engined.

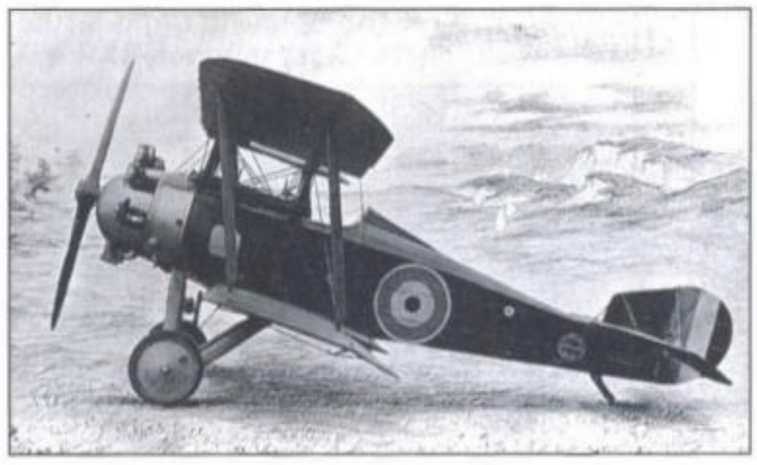


Armstrong Whitworth Ara

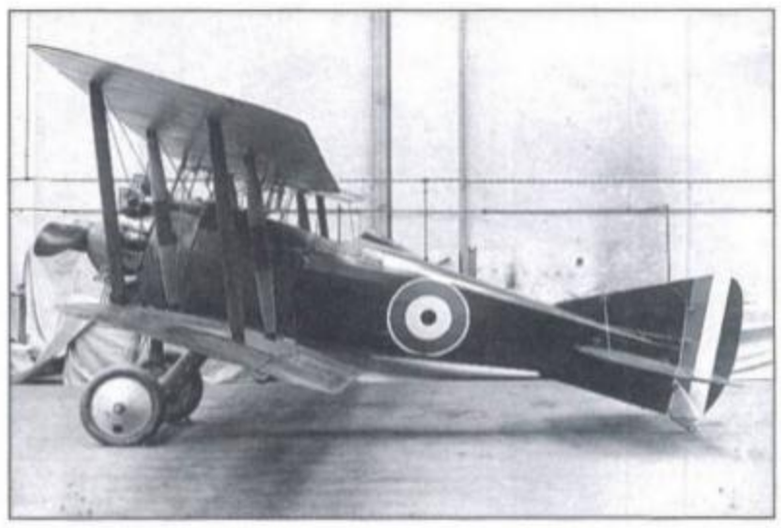
B.A.T. F.K.22 Bantam II

B.A.T. F.K. 25 Basilisk

Sopwith Snapper



Westland Wagtail



Above: As originally built, the Nighthawk had the unreliable A.B.C. Dragonfly radial. Aircraft were re-engined with Jaguar and Jupiter engines.

Below: No. 203 Sqn used the Gloster (Nieuport) Nightjar during the Chanak crisis of 1923. The Nightjar was the RAF version of the Mars Mk X, powered by a Bentley B.R.2 radial.

Above: Sporting solar topees, No. 1 Sqn ground crew pose by one of the unit's Nighthawks at Risalpur. The aircraft is powered by a 385-hp (287-kW) Bristol Jupiter II radial for service trials in tropical conditions.

Left: A total of 22 Nieuport Nightjars was procured as emergency fighters for the RAF. The type had been developed as a carrierborne fighter, and was used from HMS Argus.

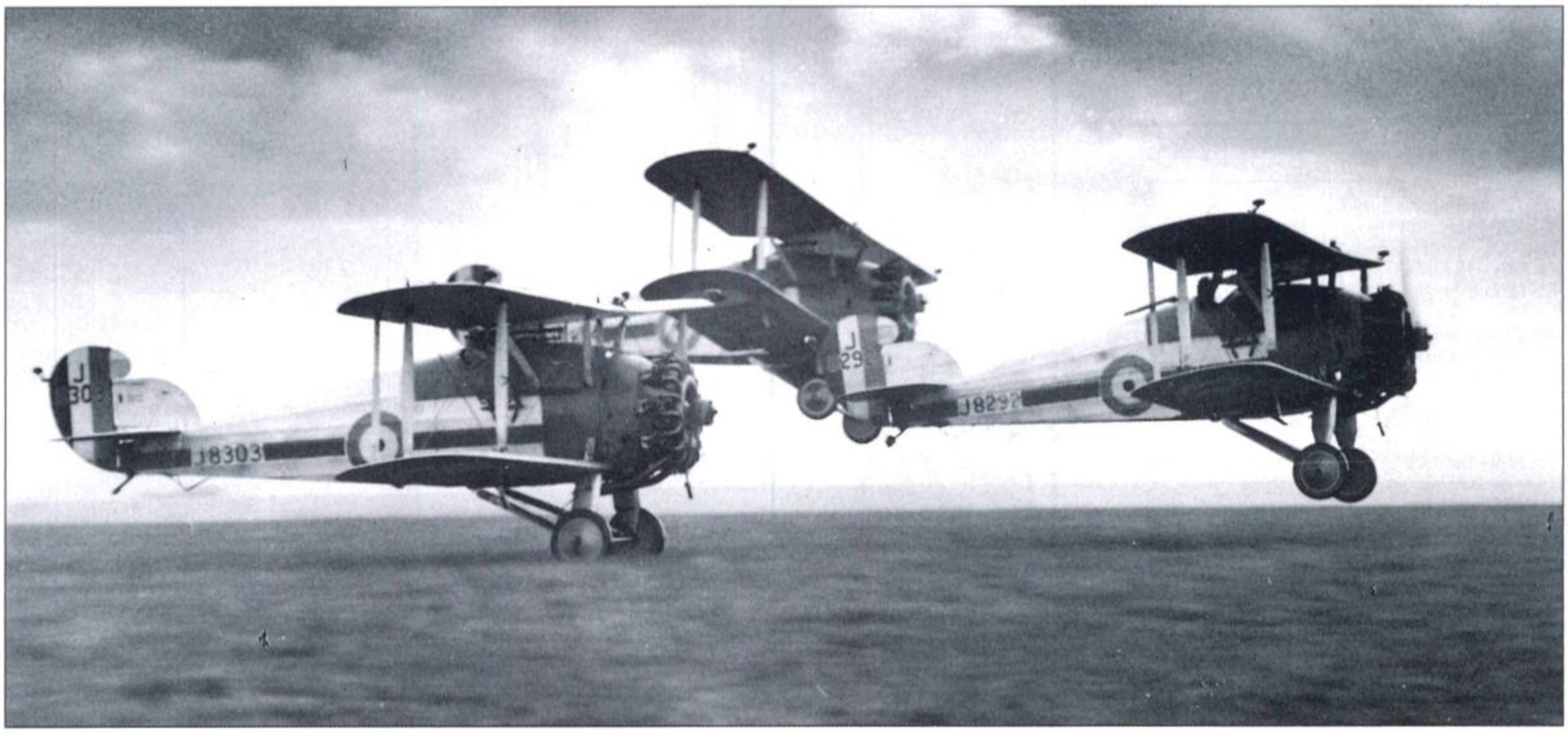
the Great British Public was impressed at seeing their aerial safety rest upon nine Sopwith Snipes, aircraft with a 230-hp (172-kW) Bentley rotary engine giving it a maximum speed of 121 mph (195 km/h) at 10,000 ft (3048 m), having first taken 10 minutes to climb that high. During the year two more Snipe squadrons were reformed, both overseas. No. 3 Squadron came into being at Ambala in India on 1 April and No. 56 at Aboukir in Egypt on 1 February.

The RAF had produced a requirement entitled Type 1 S.S. Fighter, which brought forth an array of designs from a British aircraft industry starved of orders since peace had broken out. The purpose was to provide a radial-engined successor to the Snipe – Sopwith offered the Snark, Snapper and Snail; Westland the Wagtail; Nieuport (i.e., British Nieuport) the Nighthawk; B.A.T. the Basilisk; and Bantam and Armstrong Whitworth the Ara. From this array the Nieuport Nighthawk was selected.

In 1920 the British Nieuport company was taken over by the Gloucestershire (later Gloster) Aircraft Co., which produced the 63 aircraft ordered by the RAF. The Nighthawk was easily re-engined and in its time used the 320-hp (240-kW) ABC Dragonfly and subsequently the 385-hp (290-kW) Bristol Jupiter II and 325-hp (245-kW) Armstrong Siddeley Jaguar II.

Snipe in service

The Sopwith Snipe soldiered on. In May 1920 No. 1 moved to Bangalore. No. 56 sent a detachment to San Stefano in February and remained there for three years, long after the squadron itself had disbanded. The original precursor of Fighter Command, No. 25 Squadron at Hawkinge, inevitably equipped with Snipes, maintained the defence of Great Britain. Although nominally backed up by No. 203



Above: A classic photograph shows a vic of No. 3 Sqn Woodcocks getting airborne from Upavon.

Right: Partnering No. 3 at Upavon was No. 17 Sqn. The Woodcock was not an outstanding success, but did provide additional fighter protection, especially for night operations.

Below: The Parnall Panther was a naval two-seat fighter used briefly in the early 1920s by No. 205 Sqn. The aircraft subsequently served with Fleet Air Arm flights.

Squadron at Sealand with its Sopwith Camels, in reality the latter squadron was earmarked for naval co-operation duties. This was the state of the RAF's fighter force, or lack of it, through 1921 and into 1922. No. 3 Squadron had disbanded at Ambala in September 1921 and reformed in the naval reconnaissance role on 1 October, thus cutting down fighter availability by one squadron.

On 1 January 1922, fighter forces comprised No. 25 Squadron at Hinaidi with the Sopwith Snipe, and No. 56 Squadron at Aboukir with the Sopwith Snipe.

Mention should also be made here of the Parnall Panther, although this aircraft was built purely for fighter-reconnaissance duties in co-operation with the Royal Navy. A total of 150 Panthers was built, which entered service at Leuchars on 15 April 1920. The aircraft was powered by the inevitable 230-hp (175-kW) Bentley B.R.2 rotary engine giving it a maximum speed of 108 mph (175 km/h). The Panther's armament was one Lewis gun operated by the observer who sat aft of the pilot. No. 205 Squadron was reformed to operate the type and carried out this role exclusively until 1 April 1923, when it was disbanded into Nos 440, 441 and 442 Flights.

Cautious expansion

1923 was an important year for the RAF. In Parliament, the Salisbury report recommended a Home Defence Force of 52 squadrons, subsequently authorised by the Prime Minister. Although it took more than a decade to establish such numbers, the move enabled the RAF to progress and expand within the confines of budgetary restraints. Two RAF stations were reopened at Duxford and Kenley to cater for the expansion of the fighter force. They were both in the south of England, for it was reasoned – not without justification – that any potential air attacks would come from the continent and few aircraft would have the necessary range and bomb load to reach the northern parts of the country. Two other stations were given a fighter complement, Northolt and Biggin Hill. The actual number of fighter squadrons was eight.

The order of battle on 1 January 1924 was:

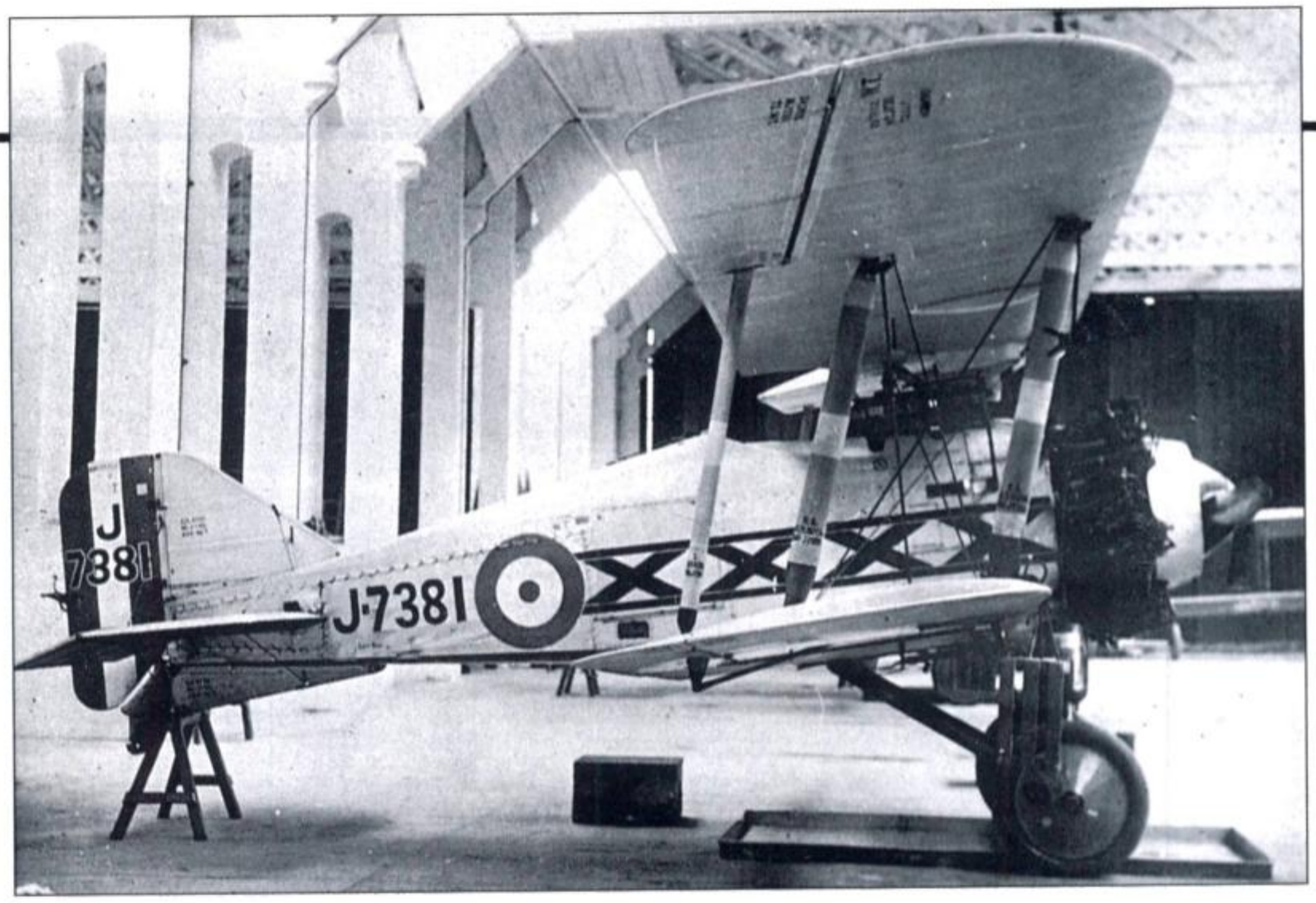
Duxford	No. 19 Squadron, No. 29 Squadron, No. 111 Squadron
Hawkinge	No. 25 Squadron
Kenley	No. 32 Squadron
Northolt	No. 41 Squadron
Biggin Hill	No. 56 Squadron

These units were still universally equipped with the Sopwith Snipe. The Nighthawk had entered service briefly in 1923 as back-up for the Snipes of No. 1 Squadron and No. 8 Squadron (DH.9As) at Hinaidi, but they had soon left the scene clear for the Snipe.

Change was in the wings. New prototypes were appearing steadily, edging up the performance in terms of speed, rate of climb and ceiling, the three parameters of greatest importance to an interceptor fighter whose role is defence.

RAF fighter squadrons
1 January 1920 to 31 December 1929

DATE	BASE	TYPE
No. 1 Squadron		
Jan 1920 – May 1920	Risalpur	Snipe, Nighthawk
May 1920 – Apr 1921	Bangalore	Snipe, Nighthawk
Apr 1921 – Nov 1926 (disbanded)	Hinaidi	Snipe
Feb 1927 (reformed) – Dec 1929	Tangmere	Siskin IIIA
No. 3 Squadron		
Feb 1920 – Oct 1921 (disbanded)	Ambala	Snipe
Apr 1924 (reformed) – Apr 1924	Manston	Snipe
Apr 1924 – Aug 1925	Upavon	Snipe
May 1925 – Aug 1928	Upavon	Woodcock II
Aug 1928 – Jun 1929	Upavon	Gamecock I
Jun 1929 – Dec 1929	Upavon	Bulldog II
No. 17 Squadron		
Apr 1924 (reformed) – Mar 1926	Hawkinge	Snipe
Mar 1926 – Oct 1926	Hawkinge	Woodcock II
Oct 1926 – Jan 1928	Upavon	Woodcock II
Jan 1928 – Sep 1929	Upavon	Gamecock I
Sep 1929 – Dec 1929	Upavon	Bulldog II
No. 19 Squadron		
Apr 1923 (reformed) – Dec 1924	Duxford	Snipe
Dec 1924 – Apr 1928	Duxford	Grebe II
Mar 1928 – Dec 1929	Duxford	Siskin IIIA
No. 23 Squadron		
Jul 1925 (reformed) – Apr 1926	Henlow	Snipe
Apr 1926 – Dec 1929	Henlow	Gamecock I
No. 25 Squadron		
Apr 1920 (reformed) – Sep 1922	Hawkinge	Snipe
Sep 1922 – Oct 1923	San Stefano	Snipe
Oct 1923 – Oct 1924	Hawkinge	Snipe
Oct 1924 – Jul 1929	Hawkinge	Grebe II
Jul 1929 – Dec 1929	Hawkinge	Siskin IIIA
No. 29 Squadron		
Apr 1924 (reformed) – Jan 1925	Duxford	Snipe
Jan 1925 – Mar 1928	Duxford	Grebe II
Mar 1928 – Apr 1928	Duxford	Siskin IIIA
Apr 1928 – Dec 1929	North Weald	Siskin IIIA
No. 32 Squadron		
Apr 1923 (reformed) – Dec 1924	Kenley	Snipe
Nov 1924 – Feb 1927	Kenley	Grebe II
Sep 1926 – Apr 1928	Kenley	Gamecock I
Apr 1928 – Dec 1929	Kenley	Siskin IIIA
No. 41 Squadron		
Apr 1923 (reformed) – May 1924	Northolt	Snipe
May 1924 – Mar 1927	Northolt	Siskin III
Mar 1927 – Dec 1929	Northolt	Siskin IIIA
No. 43 Squadron		
Jul 1925 (reformed) – Aug 1926	Henlow	Snipe
Mar 1926 – Dec 1926	Henlow	Gamecock I
Dec 1926 – Jun 1928	Tangmere	Gamecock I
Jun 1928 – Dec 1929	Tangmere	Siskin IIIA
No. 56 Squadron		
Feb 1920 – Sep 1922 (disbanded)	Aboukir	Snipe
Nov 1922 (reformed) – May 1923	Hawkinge	Snipe
May 1923 – Nov 1924	Biggin Hill	Snipe
Nov 1924 – Sep 1927	Biggin Hill	Grebe II
Sep 1927 – Dec 1929	North Weald	Siskin IIIA
No. 111 Squadron		
Oct 1923 (reformed) – Jan 1924	Duxford	Snipe
Jan 1924 – Jan 1925	Duxford	Snipe, Grebe II
Jan 1925 – Nov 1926	Duxford	Siskin III
Nov 1926 – Apr 1928	Duxford	Siskin IIIA
Apr 1928 – Dec 1929	Hornchurch	Siskin IIIA
No. 203 Squadron		
Jan 1920 – Jan 1920 (disbanded)	Scopwick	Camel
Mar 1920 (reformed) – Sep 1922	Leuchars	Camel
Sep 1922 – Dec 1922	HMS *Argus*	Nightjar
Dec 1922 – Jan 1923	HMS *Kilya Bay*	Nightjar
Jan 1923 – Apr 1923 (disbanded)	HMS *Argus*	Nightjar
No. 205 Squadron		
Apr 1920 (reformed) – Apr 1923	Leuchars	Panther



Above: A Grebe Mk I of No. 29 Sqn is seen in the hangar at Duxford. Power came from the 400-hp (298-kW) Bristol Jupiter IV.

Right: This Grebe Mk II served with a base training unit. A small batch was built as Grebe (Dual) two-seat trainers.

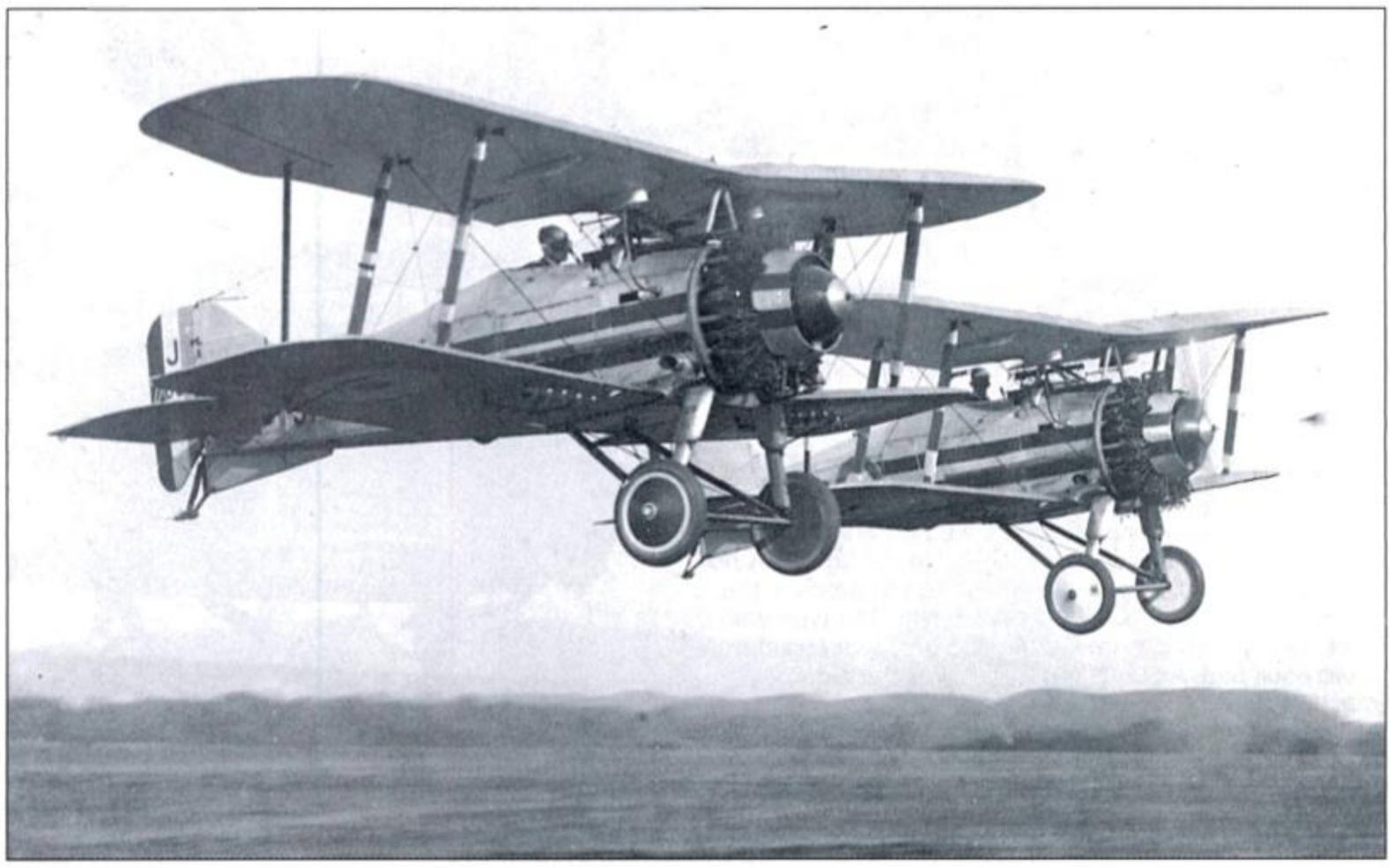
Left: This company aircraft displays the upper wing blister fuel tanks. The Grebe featured Gloster's H.L.B. high-lift aerofoil section.

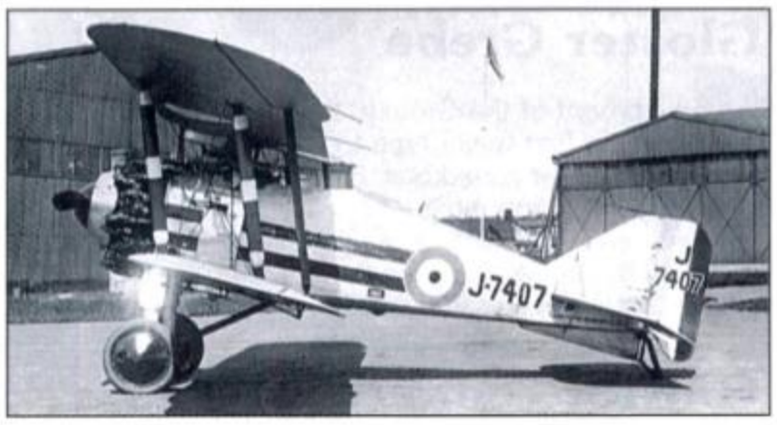
Below: This Grebe was on the strength of No. 32 Sqn, and is seen beside a No. 29 Sqn aircraft. The two Vickers guns were mounted above the forward fuselage.

Coincidental with the arrival of the Siskin was that of the Grebe. Both types had been ordered into production for the RAF and both came into service in 1924. First of these two aircraft to enter squadron service was the Siskin III, which joined No. 41 Squadron in May 1924 at Northolt. While No. 41 was working out the bugs of the Siskin, Grebe IIs came in with a rush in the second half of 1924 to Nos 56 Squadron at Biggin Hill in September, 32 Squadron at Kenley in November, and 19 at Duxford in December. This still left six squadrons with the Snipe, a wartime type still in service fully seven years after the war's end.

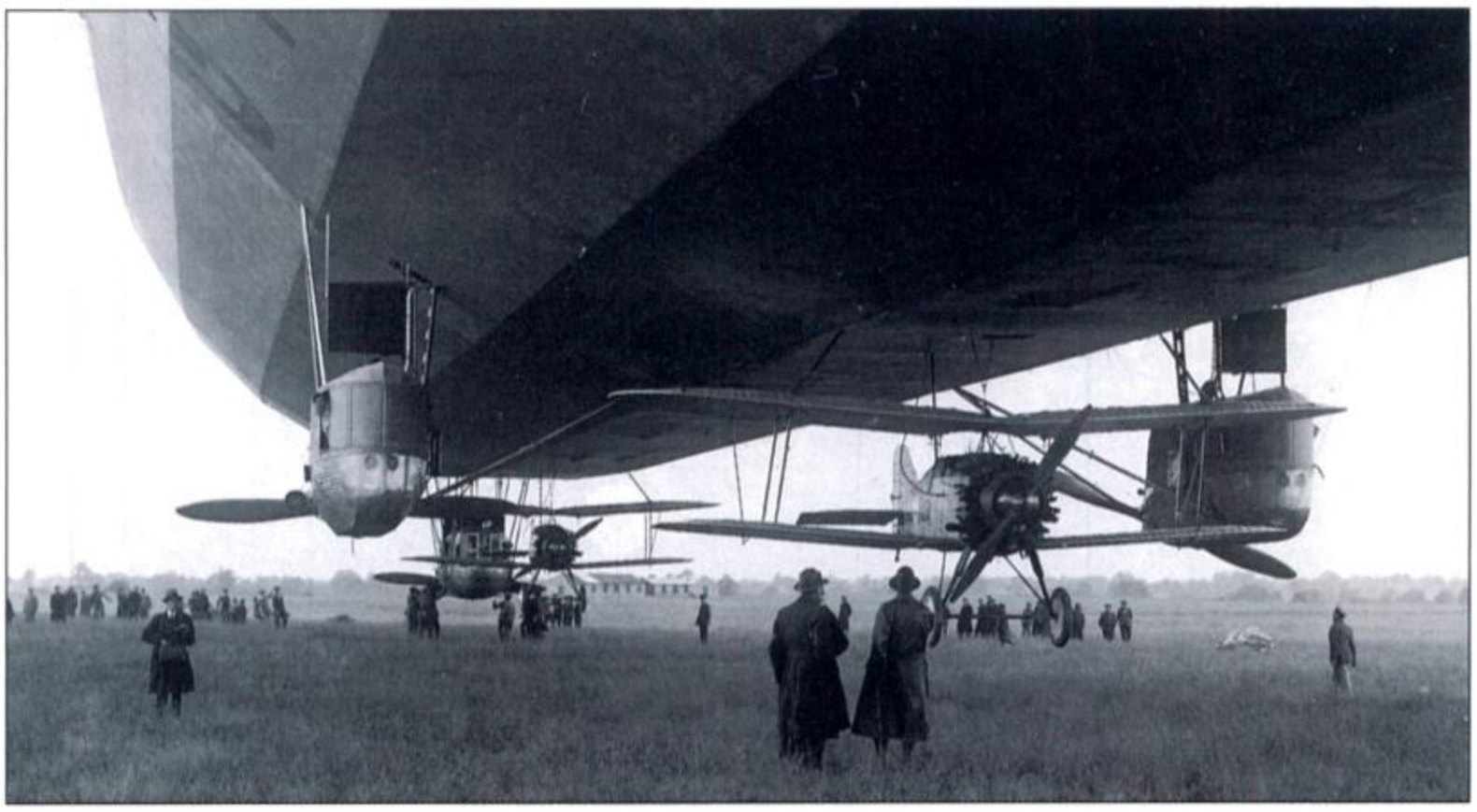
About this time, with the upsurge of *esprit de corps* in the renascent Royal Air Force, it became fashionable to sport coloured markings to denote squadron ownership, a vogue which is still in existence. No. 1 Squadron in India (Hinaidi) with its Snipes did not participate. No. 3 Squadron at Upavon put green bars on its Snipes, No. 17 Squadron at Hawkinge (having reformed there on 1 January 1924) a double black zigzag, No. 19 Squadron at Duxford with

Above, right and below: The parallel black lines along the fuselage and upper wing were the markings of No. 25 Squadron at Hawkinge, which flew the Grebe from 1924 to 1929. Although No. 111 Sqn had a Grebe flight from January 1924, No. 25 was the first unit to fully convert to the pugnacious Gloster fighter.





Below: On 21 October 1925 two Grebes were successfully air-launched from the R.33 airship, one over Pulham and one over Cardington.



Above: No. 19 Sqn chose a light blue/white checkerboard pattern for its squadron markings, seen here on a Grebe.

Below: This is a Grebe of No. 32 Sqn. The type was used for several experiments, including terminal velocity dives in which a speed of 240 mph (386 km/h) was recorded. Other tests included firing Browning 0.50-in (12.7-mm) machine-guns.

	Armstrong Whitworth Siskin Mk III	Gloster Grebe Mk II
Powerplant	325-hp (245-kW) A.S. Jaguar III	400-hp (300-kW) A.S. Jaguar IV
Wing span	33 ft 1 in (10.08 m)	29 ft 4 in (8.93 m)
Weight, loaded	2,735 lb (1240 kg)	2,614 lb (1186 kg)
Speed	max 134 mph (215 km/h) at 6,500 ft (1980 m)	max 152 mph (245 km/h) at sea level
Performance	climb to 6,500 ft (1980 m) in 5 min	climb to 20,000 ft (6096 m) in 23 min
Service ceiling	20,500 ft (6248 m)	23,000 ft (7010 m)
Armament	two 0.303-in Vickers guns	two 0.303-in Vickers guns

Grebes a blue/white checkerboard, No. 29 at Duxford red crosses surmounted and overscored by red lines, No. 111 Squadron at Duxford with Snipes a black bar, No. 25 Squadron at Hawkinge a double black band, No. 32 Squadron at Kenley a blue bar diagonally crossed by white lines, No. 41 Squadron at Northolt a red bar, and No. 56 Squadron at Biggin Hill a red and white checkerboard.

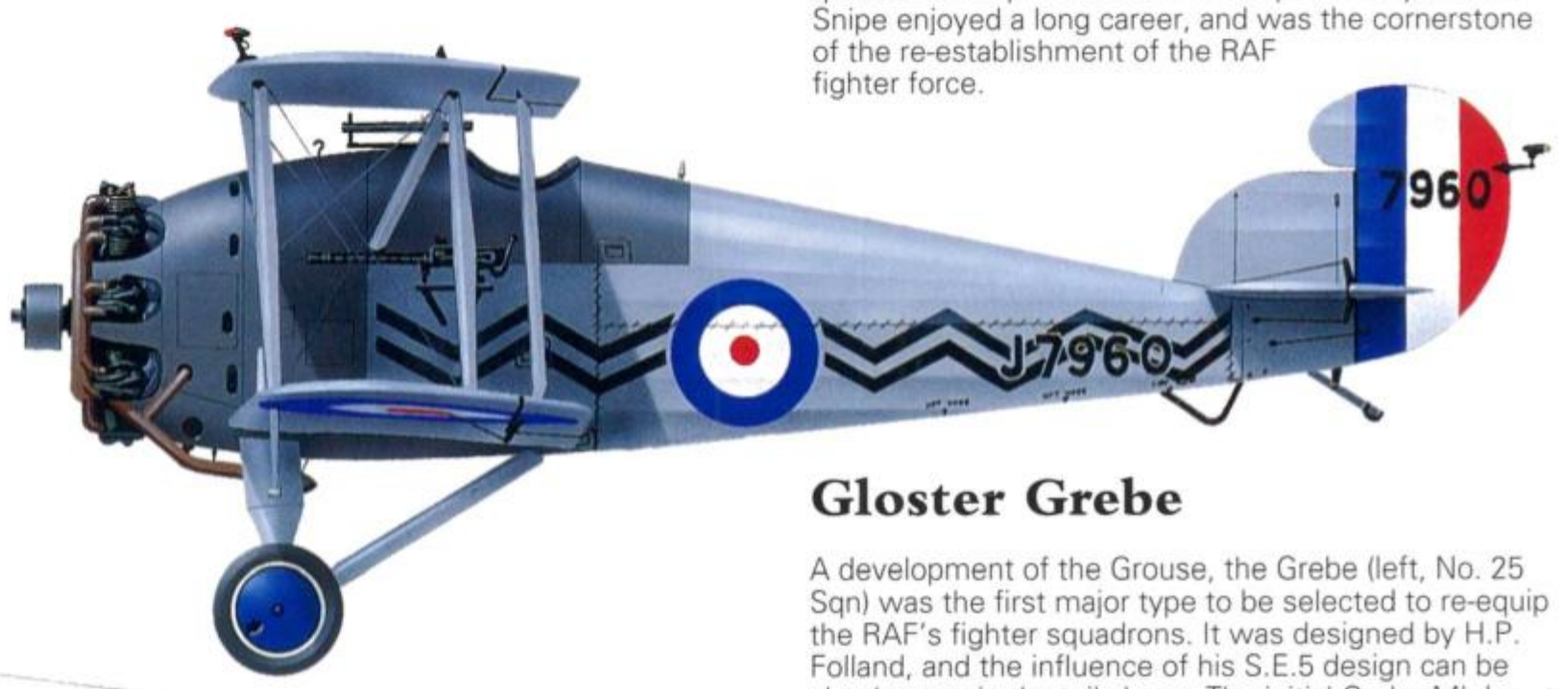
So remained the state of the RAF's fighter force through 1925, apart from Nos 25 at Hawkinge and 29 at Duxford re-equipping with the Grebe, and the Hawker Woodcock coming into service with No. 3 Squadron at Upavon.

The latter aircraft was introduced ostensibly to see the last Snipes out of service. In practice, it was a more stable, less manoeuvrable machine. The Mk II version was a single-bay biplane with a 420-hp (315-kW) Bristol Jupiter IV engine but a maximum speed of only 138 mph (222 km/h). Two squadrons were equipped with it, Nos 3 and 17 at Upavon. They were set aside to some extent in that they were to develop the night-fighting role in the RAF, for which the Woodcocks were admirable, being stable aircraft. They remained in service in this duty until 1928.

For the first time since World War I, the Royal Air Force had achieved a balanced air force of the size commensurate with its peacetime requirements. Its fighter force was set out deliberately in the shape of a crescent stretching from Upavon in the west, through the air fields around London up to Duxford in East Anglia and Henlow to its west. The task of the squadrons was to hone their performance and ability, and this was done by participation in the annual air exercises and particularly by competition for participation in the RAF Display at Hendon, which was the climax of the year for the Royal Air Force. The competition was fierce in several specific contests and squadrons selected for display considered themselves the elite of the Royal Air Force.

Sopwith Snipe

Undoubtedly the best Allied fighter of World War I, the 7F.1 Snipe (left, No. 56 Sqn) was the natural successor to the Camel. It was designed around the Bentley B.R.2 rotary engine but with few of the tricky handling qualities of its predecessor. In the post-war years the Snipe enjoyed a long career, and was the cornerstone of the re-establishment of the RAF fighter force.



Hawker Woodcock Mk II

The first of a proud line of single-seat fighters to bear the Hawker name, the Woodcock (right, No. 17 Sqn) was not an initial success, resulting in a redesign to produce the Woodcock Mk II with a Jupiter IV engine. The type was considered as an interim fighter, and only two squadrons were equipped. An unusual feature was the external machine-guns.

Gloster Grebe

A development of the Grouse, the Grebe (left, No. 25 Sqn) was the first major type to be selected to re-equip the RAF's fighter squadrons. It was designed by H.P. Folland, and the influence of his S.E.5 design can be clearly seen in the tail shape. The initial Grebe Mk I was followed by the Mk II with a thinner wing centre-section and revised ailerons.

Gloster Gamecock Mk I

Successor to the Grebe, the Gamecock (No. 32 Sqn, below) emerged initially with a similar fin, but this was quickly replaced by a unit with horn-balanced rudder. Blessed with outstanding agility, the Gamecock was a favourite aerobatic mount, but it had several handling vices and suffered from wing flutter, necessitating a strengthening V-strut on later aircraft.

The Gamecock Mk II was not adopted by the RAF, although at least one example was used for trials by the RAE.

A No. 23 Sqn pilot awaits some 'erks' to start up the Gamecock's Jupiter VI. Note the machine-guns mounted in side troughs.

In 1925 the final two squadrons were formed to make this fighter force complete. On 1 July 1925 Nos 23 and 43 Squadrons reformed at Henlow, where they received Sopwith Snipes on which to work up.

Meanwhile, the aircraft industry was, of course, aiming to sell more aircraft to the Royal Air Force. The two main producers of fighter aircraft, Armstrong Whitworth and Gloster, set about refining their products, but in different ways.

Armstrong Whitworth decided that they had a basically good airframe in the Siskin III; it was the first all-metal structured aircraft to go into operational service with the Royal Air Force, and all that was needed was to clean up the aircraft and add more power. The fuselage was duly streamlined, particularly with the deletion of the ventral fin and the dihedral on the upper wing. The main alteration was the substitution of the Jaguar III engine on the Mk III by the Jaguar IV on the Mk IIIA. The horsepower available jumped from 325 to 400 (244 to 300 kW), which increased the maximum speed from 134 to 156 mph (215 to 250 km/h), the service ceiling from 20,000 to 27,000 ft (6096 to 8230 m) and the rate of climb to 15,000 ft (4570 m) from 16.5 to 10.5 minutes. Provision was also made for four 20-lb (9-kg) bombs under the wings.

Agile Gamecock

Gloster tackled the task differently. The general unreliability of the Armstrong Siddeley Jaguar, with which the Grebe had been equipped, led the Air Ministry to issue a specification (No. 37/23) basically intended to replace the Grebe with a Bristol Jupiter-engined successor, for this new engine appeared to have overcome all of the Jaguar's faults. The new design was the easy-to-fly Gamecock Mk I, which was extremely manoeuvrable due to its configuration of snub nose, engine near the centre of gravity, and short-span wings. It also had a vicious spin and had inherited some of the tail and flutter problems of the Grebe. The aircraft was, however, a real dogfighter and, once mastered by a pilot, could outperform any other RAF fighter of its day.

Both of these new aircraft came into service in 1926, the Gamecock to No. 23 Squadron at Henlow in May and the Siskin IIIA to No. 111 Squadron at Duxford in September. These two types slowly replaced all the other fighters in

Armstrong Whitworth Siskin Mk III

In 1919 the Siddeley S.R.2 Siskin appeared, an all-wood design powered by the unfortunate A.B.C. Dragonfly radial. At the time it was not adopted for production, but did form the basis for the Armstrong Whitworth Siskin Mk III (left, No. 111 Sqn). The Mk III took advantage of a metal tubular structure, although it remained fabric-covered. Power came from a 325-hp (242-kW) Armstrong Siddeley Jaguar III, and armament was the standard two Vickers guns in the upper forward fuselage. Only two squadrons were equipped with the type.

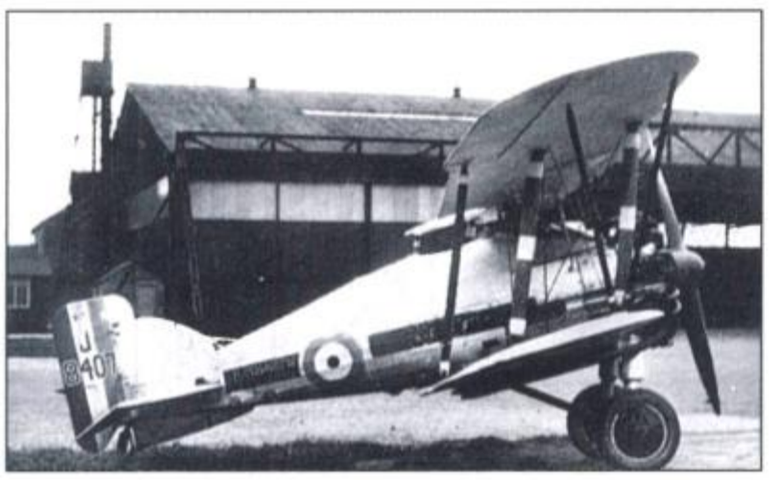
Armstrong Whitworth Siskin Mk IIIA

A development of the Mk III, the Siskin Mk IIIA (right, No. 1 Sqn) used the Jaguar IV, which in its IVS supercharged version produced 450 hp (336 kW). Although speed was not appreciably improved, the service ceiling and climb performance were much better. The rear fuselage was redesigned with the tailplane mounted higher and ventral fin deleted.

Bristol Bulldog Mk II

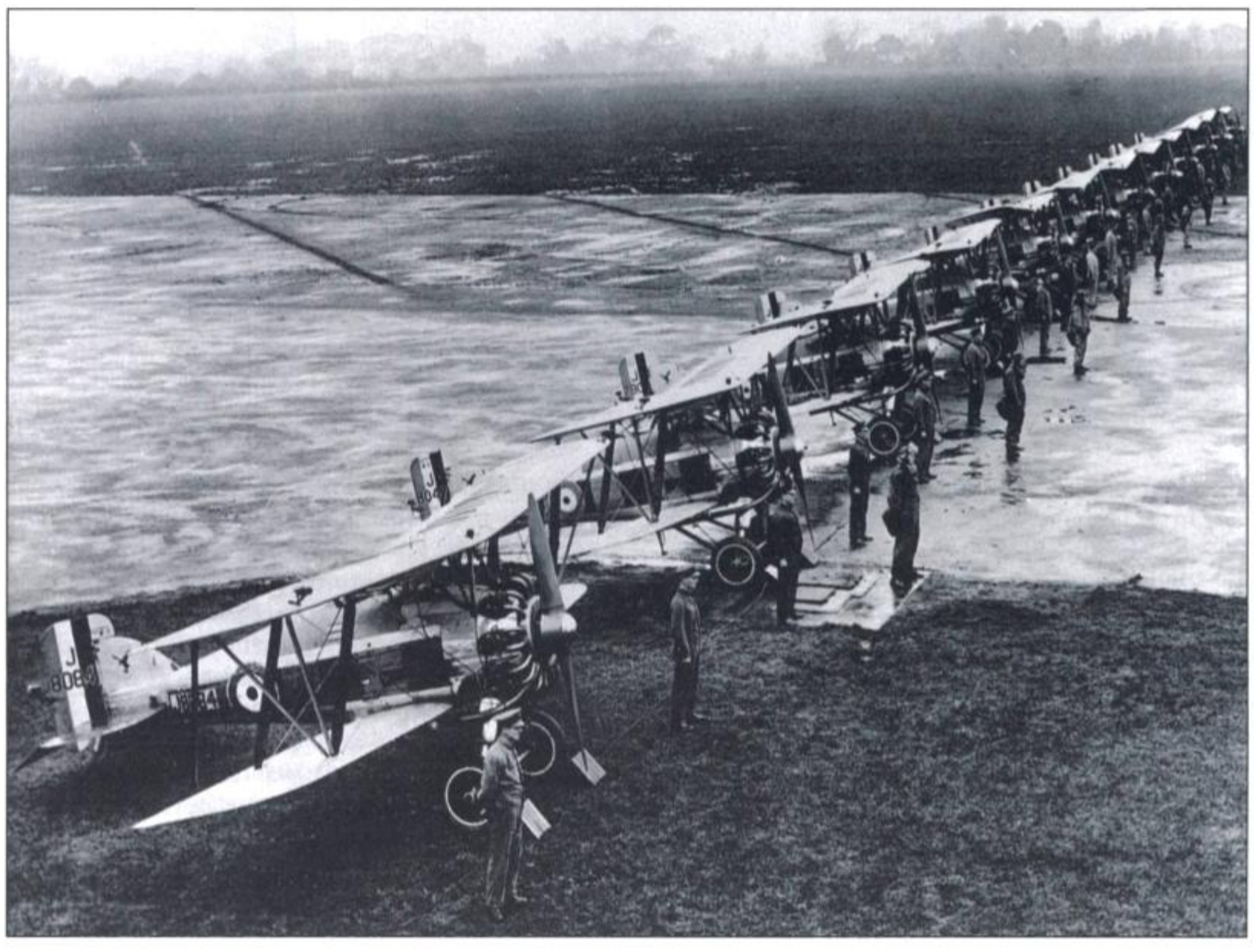
Winner of the F.9/26 competition, narrowly pipping the Hawker Hawfinch, the Bristol Bulldog proved to be a long-lived and popular choice. The first service variant was the Mk II, which introduced a longer fuselage and more shapely fin compared to the original design. Initial production aircraft had the 450-hp (336-kW) Jupiter VII, later changed for the 490-hp (366-kW) Jupiter VIIF. The Mk IIA of 1931 introduced a broader fin, tailwheel, wider main undercarriage and strengthening.

Below: This splendid line-up shows No. 23 Squadron's Gamecocks on parade at Kenley in 1927. In addition to the red/blue square markings on the fuselage, the aircraft wear on the fixed portion of the fin the squadron's badge of an eagle preying on a small bird.



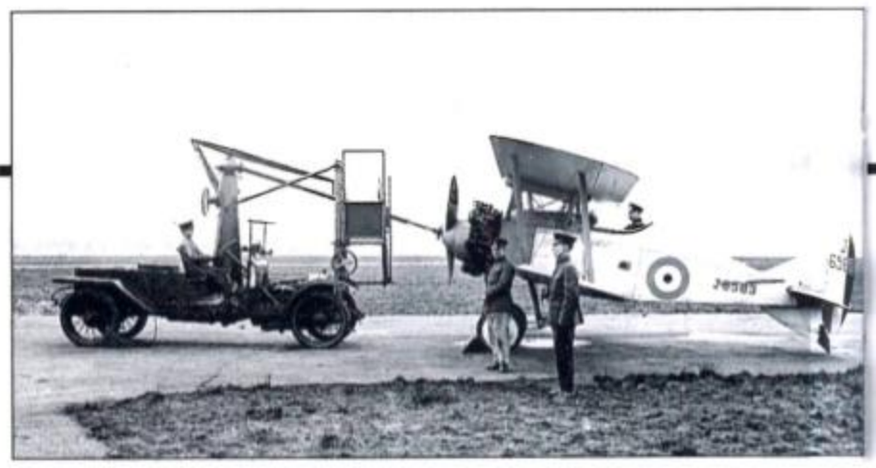
Above: The green fuselage stripe on this Gamecock Mk I marked the aircraft as belonging to No. 3 Squadron.

Below: No. 43 Squadron was the first unit to receive the Gamecock, flying from Henlow for a few months before moving to Tangmere.



Above: Despite its trickiness, the Gamecock was loved by its pilots, mainly for its aerobatic qualities. These three are from No. 32 Sqn.

Below: This vic of Gamecocks is from No. 23 Sqn. Of note is the retrofitted stiffening V-strut between the upper and lower wings.



Seen here hooked up to a Hucks starter is the first steel-tubed Siskin, forerunner of the Mk III which became the first metal fighter for the RAF.

Around 400 Siskin Mk IIIAs were delivered to the RAF. This example wears No. 19 Sqn's blue/white check markings.

The Siskin Mk IIIA was the most widespread of the 1920s, serving with nine of the fighter units. This pair is from No. 32 Sqn at Kenley.

Preceding the definitive Mk IIIA into service was the Mk III with characteristic ventral fin. This variant only served with No. 41 Sqn (red band, above) and No. 111 Sqn (black band, left).

the RAF and set a new standard for the service.

On 1 January 1929 the RAF's fighter force looked like this:

Tangmere	No. 1 Sqn	Siskin IIIA
	No. 43 Sqn	Gamecock I
Upavon	No. 3 Sqn	Woodcock II
	No. 17 Sqn	Woodcock II
Duxford	No. 19 Sqn	Grebe II
	No. 29 Sqn	Grebe II
	No. 11 Sqn	Siskin IIIA
Kenley	No. 23 Sqn	Gamecock I
	No. 32 Sqn	Gamecock I
Hawkinge	No. 25 Sqn	Grebe II
Northolt	No. 41 Sqn	Siskin IIIA
North Weald	No. 56 Sqn	Siskin IIA

In the absence of a European nation with war-like intentions, the Air Ministry deemed the force it had active and operational to be sufficient for the peacetime tasks of the Home Fighter Force. One requirement was to keep the force at maximum efficiency. This posed little difficulty, since great rivalries had developed between the squadrons which was fostered in the many contests and competitions arranged. The other requirement was to ensure that the squadrons' equipment was the best available in terms of serviceability and technology. To this end, and to have replacements for the Siskin IIIA and Gamecock well in hand, the Air Ministry issued Specification F.9/26. Most manufacturers entered designs, the principal competitors being the Armstrong Whitworth A.W.XVI, the Boulton Paul Partridge, the Bristol Bulldog, the Gloster S.S.18 and the Hawker Hawfinch.

Bulldog into production

The winner of the competition was the Bristol Bulldog, and the Mk II was ordered into production. Following that version's small production batch, the Mk IIA fulfilled all further contracts, 301 being built for the RAF as well as numerous exports.

Powered by a 440-hp (330-kW) Bristol Jupiter VIIF engine, the Bulldog achieved a

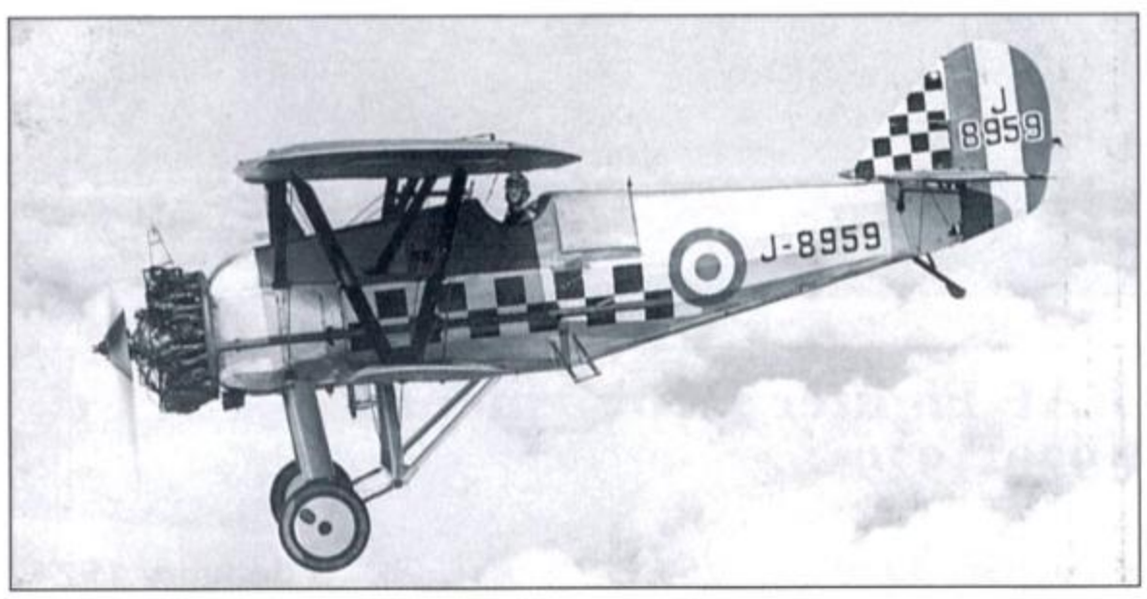
Above: A tethered formation of No. 43 Sqn's Siskin Mk IIIAs is led by the checkered-tail aircraft of the squadron leader.

Above: No. 1 Sqn returned to the fighter scene in 1927 as a Siskin Mk IIIA operator. The aircraft wore two parallel red bands.

Above: Normally based at Duxford, No. 29 Sqn flew its Siskin Mk IIIAs to Hendon for the 1929 show.

Left: No. 43 Sqn gave up its Gamecocks in favour of Siskins in 1928. It flew them until the Fury arrived in May 1931.

Right: This checkered-tail aircraft was flown by Squadron Leader C. N. Lowe, commander of the 'Fighting Cocks' of No. 43 Squadron.



maximum speed of 174 mph (280 km/h) at 10,000 ft (3048 m), could reach 20,000 ft (6096 m) in 14.5 minutes, and had a service ceiling of 29,300 ft (8930 m). Its wingspan of 33 ft 10 in (10.31 m) meant that it was manoeuvrable without the quirks of the Gamecock, being a much more pleasant aircraft to fly but agile enough to be a good dogfighter. It was very popular with the pilots, a worthy successor to a decade of RAF fighters.

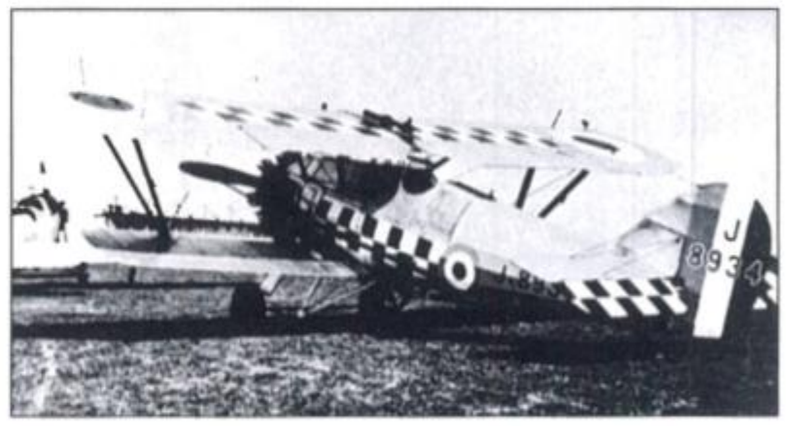
The most striking observation to come from a review of this decade of fighter development is the lack of development. The Bristol Bulldog could in fact have been a Sopwith Snipe with a more powerful radial instead of rotary engine, and a metal airframe. Fighter progress stood still for a whole decade. The maximum speed had only increased by one third, rate of climb by 1.5 (in round figures), and armament, in terms of number and calibre of guns, had not changed. Blame for this must be laid both at the Air Ministry's door and that of industry. The specifications issued for new fighter aircraft were totally lacking in foresight and imagination, adhering to just incremental increases in required performance and the totally ridiculous embargo on monoplanes (imposed in World War I because one monoplane type in service had a number of wing failures). From the manufacturers' point of view, it was easier and cheaper to stick to improving basic designs rather than to risk something new.

Within the next decade the winds of change and international competition forced Britain out of this trough. The first sign of this came at the very end of the 1920s. Rolls-Royce had developed an inline engine that gave upwards of 500 hp (375 kW), eventually to be known as the Kestrel, and Hawker had already designed and built a sleek two-seat bomber around it. This was followed by arguably the most beautiful biplane fighter ever built: the Fury. To trace this next step forward in fighter development, though, we have to look to the 1930s.

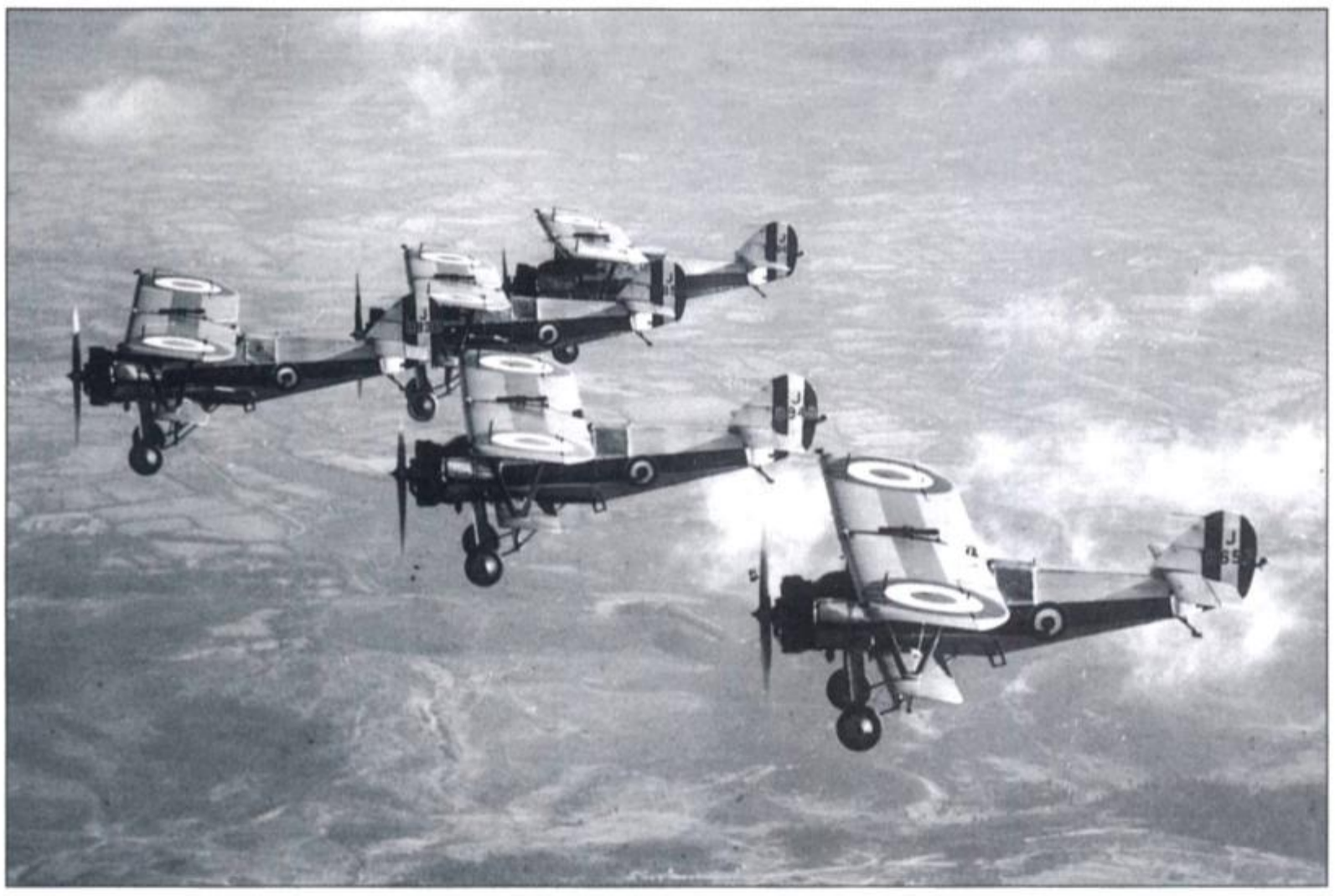
John D. R. Rawlings

Below: No. 41 Squadron upgraded from Siskin IIIs to IIIAs in March 1927, becoming the first squadron to operate the new variant.

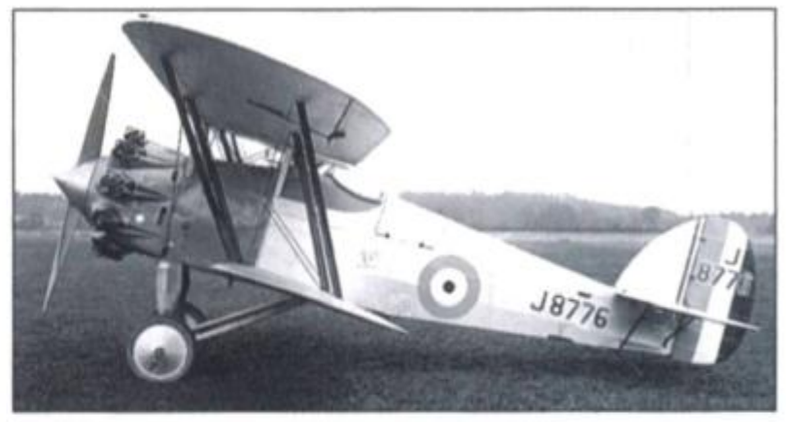
Above and left: Every Siskin squadron had at least one Siskin IIIDC two-seat trainer, this being the aircraft assigned to No. 111 Sqn.



Right: No. 56 Sqn had red/white checker markings. The unit was the last to operate the Siskin, switching to Bulldogs in October 1932.



Specification F.9/.26, eventually won by the Bulldog, also spawned the Boulton Paul P.33 Partridge (above) and Hawker Hawfinch (below). The classic 1930s outline of the Fury can be seen emerging from the Hawker fighter.



RAF Fighter Deployment 1920-1929

1 January 1920

Risalpur	No. 1 Squadron	Snipe, Nighthawk
Scopwick	No. 203 Squadron	Camel

1 January 1921

Aboukir	No. 56 Squadron	Snipe
Ambala	No. 3 Squadron	Snipe
Bangalore	No. 1 Squadron	Snipe
Hawkinge	No. 25 Squadron	Snipe
Leuchars	No. 203 Squadron	Camel

1 January 1922

Aboukir	No. 56 Squadron	Snipe
Hawkinge	No. 25 Squadron	Snipe
Hinaidi	No. 1 Squadron	Snipe

1 January 1923

Bangalore	No. 1 Squadron	Snipe, Nighthawk
Hawkinge	No. 56 Squadron	Snipe
Leuchars	No. 203 Squadron	Nightjar
	No. 205 Squadron	Panther
San Stefano	No. 25 Squadron	Snipe

1 January 1924

Biggin Hill	No. 56 Squadron	Snipe
Duxford	No. 19 Squadron	Snipe
	No. 29 Squadron	Snipe
	No. 111 Squadron	Snipe
Hawkinge	No. 25 Squadron	Snipe
Hinaidi	No. 1 Squadron	Snipe
Kenley	No. 32 Squadron	Snipe
Northolt	No. 41 Squadron	Snipe

1 January 1925

Biggin Hill	No. 56 Squadron	Snipe
Duxford	No. 19 Squadron	Grebe II
	No. 29 Squadron	Snipe
	No. 111 Squadron	Snipe
Hawkinge	No. 17 Squadron	Snipe
	No. 25 Squadron	Snipe
Hinaidi	No. 1 Squadron	Snipe
Kenley	No. 32 Squadron	Grebe II
Northolt	No. 41 Squadron	Siskin III
Upavon	No. 3 Squadron	Snipe

1 January 1926

Biggin Hill	No. 56 Squadron	Grebe II
Duxford	No. 19 Squadron	Grebe II
	No. 29 Squadron	Grebe II
	No. 111 Squadron	Siskin III
Hawkinge	No. 25 Squadron	Grebe II
Henlow	No. 23 Squadron	Snipe
	No. 43 Squadron	Snipe
Hinaidi	No. 1 Squadron	Snipe
Kenley	No. 32 Squadron	Grebe II
Northolt	No. 41 Squadron	Siskin III
Upavon	No. 3 Squadron	Woodcock II
	No. 17 Squadron	Snipe

1 January 1927

Biggin Hill	No. 56 Squadron	Grebe II
Duxford	No. 19 Squadron	Grebe II
	No. 29 Squadron	Grebe II
	No. 111 Squadron	Siskin IIIA
Hawkinge	No. 25 Squadron	Grebe II
Henlow	No. 23 Squadron	Gamecock I
Kenley	No. 32 Squadron	Grebe II
Northolt	No. 41 Squadron	Siskin III
Tangmere	No. 43 Squadron	Gamecock I
Upavon	No. 3 Squadron	Woodcock II
	No. 17 Squadron	Woodcock II

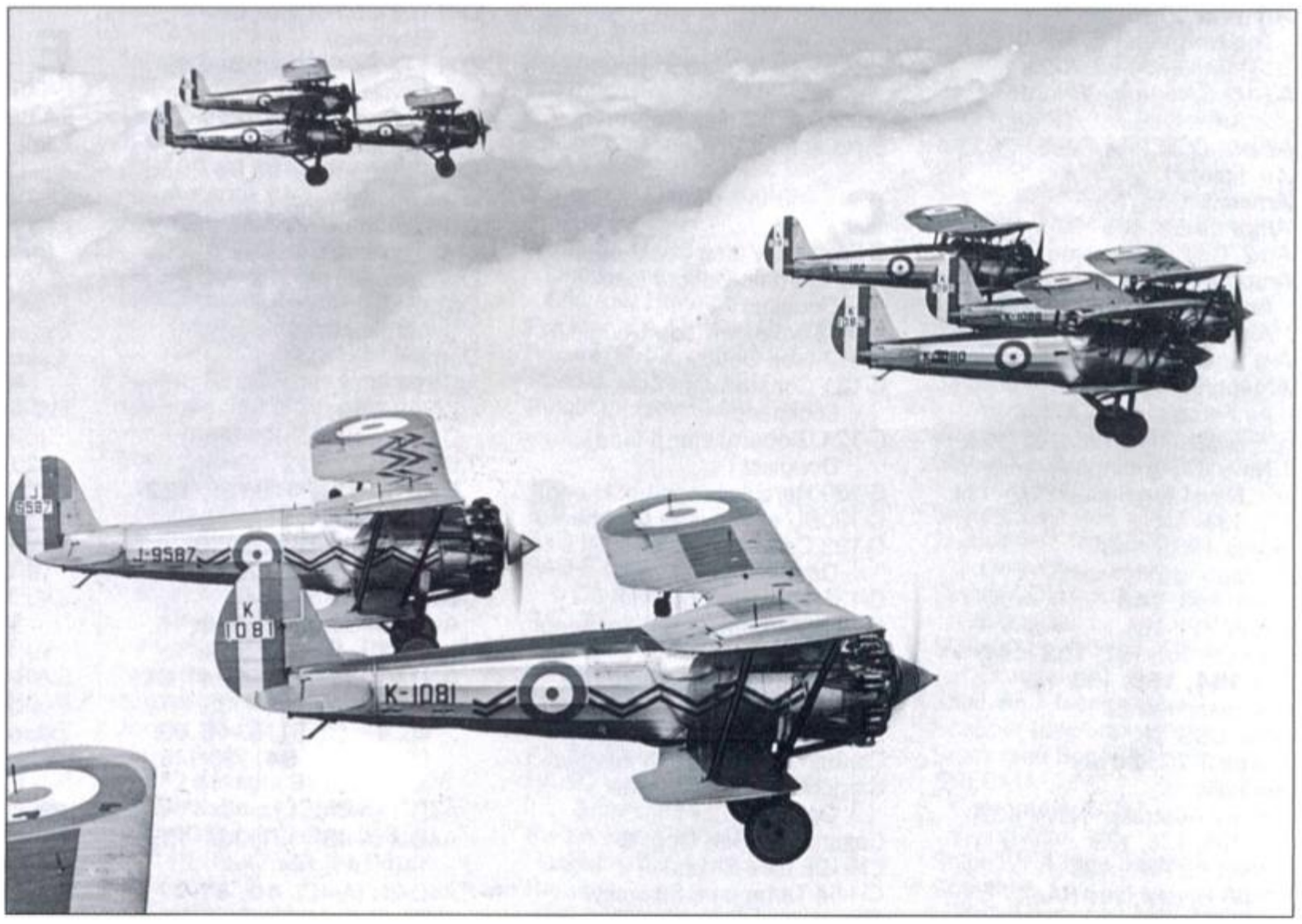
Above: Nos 3 and 17 Squadrons pioneered night-fighting in the 1920s, initially with the Woodcock and then the Gamecock. The task was continued with the Bulldog, as seen here as a No. 17 Sqn Mk IIA detachment to Kenley waits at sunset in the early 1930s.

Right: No. 3 Squadron became the first operator of the Bristol Bulldog Mk II when it acquired its aircraft in June 1929. Superseded by Mk IIAs in 1931, the Bulldog remained in service with the unit until 1937.

Above: The Bulldog was more associated with the 1930s, but the aircraft did enter service in 1929. This No. 3 Sqn machine is seen at the Andover air pageant in that year.

Right: When No. 17 Sqn formed on Bulldog Mk IIs, it inherited some of No. 3's aircraft. This group contains aircraft bearing several marking variations, including one with No. 17 fuselage zig-zags and No. 3's green bar on the upper wing.

Below: The shape of things to come – K1926 was the first production Hawker Fury, the ultimate biplane fighter of the 1930s. The prototype, at the time named Hornet, had flown in 1929.



1 January 1928

Duxford	No. 19 Squadron	Grebe II
	No. 29 Squadron	Grebe II
	No. 111 Squadron	Siskin IIIA
Hawkinge	No. 25 Squadron	Grebe II
Kenley	No. 23 Squadron	Gamecock I
	No. 32 Squadron	Gamecock I
Northolt	No. 41 Squadron	Siskin IIIA
North Weald	No. 56 Squadron	Siskin IIIA
Tangmere	No. 1 Squadron	Siskin IIIA
	No. 43 Squadron	Gamecock I
Upavon	No. 3 Squadron	Woodcock II
	No. 17 Squadron	Woodcock II

1 January 1929

Duxford	No. 19 Squadron	Siskin IIIA
Hawkinge	No. 25 Squadron	Grebe II
Hornchurch	No. 111 Squadron	Siskin IIIA
Kenley	No. 23 Squadron	Gamecock I
	No. 32 Squadron	Siskin IIIA
Northolt	No. 41 Squadron	Siskin IIIA
North Weald	No. 56 Squadron	Siskin IIIA
Tangmere	No. 1 Squadron	Siskin IIIA
	No. 43 Squadron	Siskin IIIA
Upavon	No. 3 Squadron	Gamecock I
	No. 17 Squadron	Gamecock I

1 January 1930

Duxford	No. 19 Squadron	Siskin IIIA
Hawkinge	No. 25 Squadron	Siskin IIIA
Hornchurch	No. 111 Squadron	Siskin IIIA
Kenley	No. 23 Squadron	Gamecock I
	No. 32 Squadron	Siskin IIIA
Northolt	No. 41 Squadron	Siskin IIIA
North Weald	No. 29 Squadron	Siskin IIIA
	No. 56 Squadron	Siskin IIIA
Tangmere	No. 1 Squadron	Siskin IIIA
	No. 43 Squadron	Siskin IIIA
Upavon	No. 3 Squadron	Bulldog II
	No. 17 Squadron	Bulldog II

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